



# ANNALS of SURGERY

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No 1

## CONGENITAL CYSTS AND FISTULÆ OF THE NECK\*

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EARLY in the author's surgical life the opportunity of studying and operating upon a number of recurrent thyro-glossal fistulæ cases presented itself. These cases had been admitted to the service of Dr. George H. Semken, at the N. Y. Skin and Cancer Hospital. Naturally, interest in the cause of these conditions was aroused. Later, the occasion to operate upon a patient with a complete lateral fistula arose. In all the series of thyro-glossal fistulæ cases amounted to ten cases.

This experience stimulated a closer study of the underlying causes of these interesting and somewhat unusual conditions.

In studying the literature innumerable references were found and quite a difference of opinion as to the etiological factors. Some of the more important recent works in the English literature were those of Christopher, Klingenstein and Colp, and Semken's article in Nelson's Loose Leaf Surgery together with many others.

One of the most important single contributions from abroad appeared in 1908 and 1912 by Romuald Wenglowski, a Russian surgeon and investigator living in Moscow.

Upon closer study of his monograph we were greatly impressed by the thoroughness of his work and the correctness of his theories and therefore came to the conclusion to present his principles and theories in greater detail.

Having made these studies one can readily understand why so many of these patients have recurrences of the mid-line fistulæ after operation. It is for this reason that this paper will deal with the embryological factors underlying lateral and medial cysts and fistulæ of the neck, and with the resulting principles of thorough and radical primary operations based upon the etiological factors.

The paper will be divided into three parts, the first dealing with the lateral cysts and fistulæ, the second with the medial cysts and fistulæ, while the third division will be in concise form, dealing with the other congenital conditions that may be found in the neck.

### PART I LATERAL CYSTS AND FISTULÆ OF THE NECK

*Historical Facts*—In 1832, Ascherson published an article in which he stated that these cysts and fistulæ were related to the branchial clefts, the higher the opening of the

\* Read before the New York Surgical Society, October 28, 1931.

fistula in the neck, the higher the cleft involved in its formation Heusinger stated that the opening was usually low, and that therefore the fourth cleft was more frequently involved than the second or third Bland-Sutton made a chart showing which cleft was involved and that it depended upon the location of the opening as to the cleft involved

The greatest work done on this subject appeared in the early 'eighties by His He stated that fistulae of the neck were a normal finding up to the end of the fifth embryonic week, further, that the sinus præcervicalis was the anlage for the thymus, and he mentioned the relationship between the thymus and neck fistulae The sinus præcervicalis, His stated, only rarely breaks through into the pharynx, but thereby he explained the inner opening of the neck fistulae The inner opening depends upon which of the clefts breaks through, if the second, then in the Rosenmüller groove in the supratonsillar fossa, if the third, then under the plica nervi laryngei, if the fourth, then in the pyriform sinus In 1899, His changed his opinion when he found evidences that the thymus did not develop from the sinus præcervicalis, but from the third branchial cleft

Rabl believed that the fistulae were due to the perforation of a thin membrane between the sinus cervicalis and the pharynx He called it the "Kiemengang" He felt that the third cleft was impossible as an etiological factor on account of the development of the thymus Further, the fourth cleft was impossible on account of the thick mesoderm between it and the pharynx Therefore, he believed that the second cleft was the one most responsible

In 1890 Kostanecki and Milecki made some very thorough literary studies They did not do original work, but brought order out of the chaos of all previous publications in this involved subject They believed that the outer opening had no relation to the number of the cleft involved If the outer opening depended on the cleft number then the inner opening would have to also, and the literature did not show this to be the case The inner opening was almost always in the same place, in the lower tonsillar fossa near the root of the tongue and more posterior As this region is that of the second cleft they believed this to be the one at fault The theory was that the second pharyngeal pouch broke through into the sinus cervicalis and then separated itself from the pharynx Up to the work of Wenglowski this literary work, study and theory was the best published

Wenglowski did not see the rationale of this theory Virchow's description of a case in 1865, attributed by the others to the first cleft, actually was a coincidence of an abnormality of the outer and middle ear combined with a lateral fistula of the neck Watson described a fistula which Kostanecki and Milecki ascribed to the second cleft, but the tract passed under the stylopharyngeus muscle which develops in the third branchial arch Therefore, the fistula also would have to be ascribed to the third cleft Kostanecki and Milecki themselves were annoyed by this fact, but they explained it by an abnormal course of the muscle fibres If the fistula belongs only to the second cleft, then the inner opening would have to be strictly within the field of the second cleft The boundaries are the tonsillar fossa, bounded in front by the palatoglossal arch and posteriorly by the palatopharyngeal arch It has been shown that the inner opening is not in the middle of the tonsil nor between these arches The majority of the cases described open below the tonsillar fossa next to the root of the tongue and behind the palatoglossal arch Therefore, they have a much closer relation with the third cleft, as the palatoglossal arch and the underlying muscle belong to the third and not to the second arch It is difficult to explain according to Kostanecki and Milecki's theory why a complete fistula forms an arch, the upper segment of which runs behind and mesial to the angle of the jaw It is also difficult to explain why the fistula curves downward and does not correspond to any other branchial groove, even if we believe that the second pouch had broken through into the sinus cervicalis, and both had remained open They believed that the outer opening depends on the size and descent of the cysts and the area of perforation of the cysts Upon careful study of clinical histories, however, it is quickly seen that there is a certain uniformity in the region where the outer openings occur They open anywhere along the medial border of the sternomastoid muscle, from the angle of the jaw

down to the middle of the sternum. As further evidence against Kostanietcki and Milecki's theory is the fact that the entire branchial apparatus in the human being does not spread downward onto the neck, but the second, third and fourth branchial arches pass posteriorly. Within the second arch develops the hyoid bone, while out of the third and fourth arches come the cornu of the hyoid and some of the muscles that insert on the hyoid from above. Therefore, the boundary of the branchial apparatus must be above the line bounded below by the lower border of the hyoid. The sinus cervicalis together with the third and fourth arches lies within this field, high under the angle of the jaw. As the arches and pouches are always uniform in position anatomically and topographically, therefore the fistula, if caused by the process of the opening of the cleft through the fistulous opening, would have to be in the region of the angle of the jaw and the upper portion of the neck. However, most of the fistulæ occur in the middle or lower neck and only rarely run upward and end blindly at the angle of the jaw. The histological findings of mixed ciliated and squamous epithelium also speak against the branchiogenetic origin, which would have to have ciliated epithelium near the pharyngeal opening and squamous epithelium in the more distal parts. This could never be proven. For these reasons Wenglowski made investigations to try to find another causative factor which would explain *all* of the actual findings. He has probably done more complete work in eight years of investigation than any other author. His friends in Russia furnished him with seventy-eight embryos ranging from two millimetres in size to forty-nine millimetres in size. These embryos he cut in serial sections and in the period of five years of investigative work he made wax model reconstructions of each one of these seventy-eight embryos. His findings he showed with the models, at the sixth and seventh Russian Surgical Congress, and published a monograph in Russian which described his work in detail. Besides the work on embryos he performed 144 autopsies upon the neck region of infant cadavers, in each instance making serial sections of this material, and added serial section studies of fifty-nine adult autopsies. When a man develops a theory upon the basis of such complete and intensive work we must seriously look into and consider his findings. Wenglowski studied the branchial apparatus and the development of the neck and such organs as the thymus and the thyroid glands from these embryos.

#### THE DEVELOPMENT OF THE BRANCHIAL APPARATUS

In 1825 Rathke studied the branchial apparatus in the embryo of the pig. In 1827, Von Baer found four branchial clefts in the human embryo. In 1877, Cusset stated that the first arch developed on the fifteenth day and the fourth in the first half of the second month. All arches he found tended to join with those of the opposite side. The arch was composed of mesoderm, the outer side covered with flat, and the inner with cylindrical epithelium. All of the arches develop in the region of the base of the skull, but some of them by their rapid growth are forced down into the neck region. The edges of the fourth arches are rounded. They grow together much faster outside than inside. Therefore the epithelium on the outer clefts must disappear faster. If it does not, all sorts of pathological conditions can develop. Before the end of the second month all clefts are closed. The arches meet in the mid-line and form a bridge from side to side. The closure of the outer end of the branchial arches lies in a line drawn from the lesser cornu of the hyoid bone to the sternoclavicular joint.

In 1881, His began his publications. He was the first to work with human embryos, and to make reconstruction wax models. His main advance was in the description of the exact position of the branchial arches. The first arch meets in the mid-line and the lower arches are separated further and further in a young embryo, thereby forming a triangle which he called the "mesobranchial field." As growth takes place the arches telescope over one another, so that the second overlies the third and the third the fourth as seen from without, while from within the pharynx the fourth overlies the third and the third the second. At the same time the third and fourth arches are covered by the wall of the neck so that a depression is caused which His called the "sinus præcervicalis."

This is a projection which develops in the human embryo between the second branchial arch and the primary chest wall. At the beginning of the second month the growth of the branchial apparatus stops. At this time the second arch covers over the sinus. The entrance into the sinus is triangular with the base below and the point above. It is bounded in front or ventrally by the curved edge of the second arch, below by the chest wall, and behind or posteriorly by the lateral wall of the neck. In the eleven- to twelve-millimetre embryo the sinus præcervicalis is completely covered over and has disappeared.

In 1883, G. Born did magnificent and perfect detailed work with a pig's embryo. He showed in his reconstruction models that the anterior part of the tongue develops from the first arch. Opposing His's findings he showed that there was a blind, short prolongation to the third branchial pouch covered by several layers of pavement epithelium. This prolongation he considered to be the thymus anlage.

In 1888, Piersol showed in his work on rabbit embryos that the perforation of the dividing membrane between the cleft and the pouch can occur only in the second branchial cleft.

In 1889, Von Liessner stated that one had to accept the theory of the patency of the branchial clefts in all types of anomalies. In 1902, Hammar (Upsala) published a work based on the human embryo, but he had used only those of three, five and eight millimetres. Then, in 1912, Wenglowski published the monograph in which he gave the findings of the detailed work on human embryos, beginning with two millimetres and ending with forty-nine millimetres, undoubtedly the most thorough work that has been done on this subject.

Wenglowski began with an embryo of 26 millimetres and ended with the embryos in which there was no evidence of the branchial apparatus.

#### TWO-AND-SIX-TENTHS-MILLI-

FIG. 1.—2.6 millimetre embryo. Model of upper portion (Wenglowski). a—Heart region b—Nasofrontal process c—Cephalic end d—Bulge of first branchial arch e—Bulge of second branchial arch f—Cut end of amnion

**METRE EMBRYO**—The 2.6-millimetre embryo shows only the first and second branchial arches with an indication of the first cleft. The first arch has distinct free ends anteriorly bordering the mouth opening. The second arch lies close to the anlage of the heart. Between these two arches lies the first branchial cleft (Fig. 1). Sagittal section shows even as early as this that the branchial pouches are evident and run in the same direction as the outer branchial clefts (Fig. 2).

**SIX-AND-FIVE-TENTHS-MILLIMETRE EMBRYO**—Here the relations are much more complicated due to the almost complete development of the branchial apparatus which lies obliquely, from below and anterior, upwards and posterior and almost on top of the upper surface of the heart. In Fig. 3 all four arches and clefts are to be seen.

**The first arch**—This consists of two portions. From the lateral portion of this arch the upper jaw develops, and from the anterior portion the lower jaw develops (Fig. 4).

**The second arch**—This also consists of two portions. The thickened part of the

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lateral portion forms the so-called operculum (outgrowth) and covers the third arch. The anterior portion grows to meet the one from the opposite side, and, as shown in the figure, forms a narrow, thin strip.

*The third arch*—This is much smaller than the first and second arches, and lies closer to the mid-line than the first and second. More than one-half of it lies buried under the operculum of the second arch. Where the two portions meet, a small operculum also seems to be formed. The medial end gets thinner and thinner and finally disappears completely near the mid-line.

*The fourth arch*—This arch is even smaller than the third and lies almost entirely buried beneath the third arch, deep in the recess between the head and the heart region of the embryo. There is an indication here also of two portions. The anterior ends join with the anterior ends of the third arch.

Viewed from in front the first branchial arches meet to form a broad union of the lower jaw. The second arches meet to form a narrow union, and the third arches do not meet in the mid-line but pass upwards to join onto the second arches.

*The first branchial cleft*—At the posterior end of the floor of the first cleft is a depression, cylinder-like in shape, ending in a thin membrane. The latter will go to form the external auditory canal. From here the cleft becomes shallower as it goes anteriorly.

*The second branchial cleft*—This is almost entirely buried under the operculum of the second arch. The floor is divided into two portions, a lateral and a medial. The lateral portion becomes deeper and narrower, and is separated from the second branchial pouch by a thin membrane. The medial portion becomes very shallow near the mid-line.

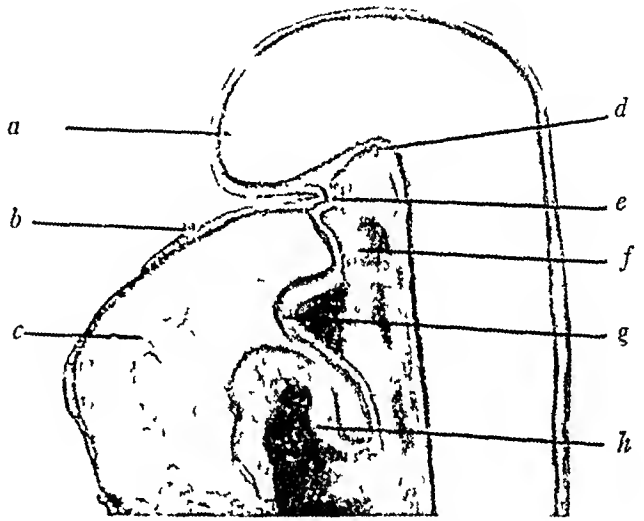


FIG. 2.—Sagittal section of same embryo as seen from within. One sees the upper end of the digestive tract, pharynx and anlage of the respiratory system and liver. (Wenglowski) a—Nasofrontal process b—Cut edge of amnion c—Heart bulge d—Pharyngeal lining e—Pharynx f—Pharyngeal pouch g—Anlage of trachea h—Anlage of heart

*The third branchial cleft*—This is similar to the second but smaller and shorter. It also has two portions and is separated from the third pouch the same as the second cleft.

*The fourth branchial cleft*—This is even more shallow but wider than the third cleft. It is bent at an angle of 60° and opens anteriorly and laterally. The floor of this cleft is fairly wide. As the fourth branchial arch, so the fourth branchial cleft is hidden in the depression which is formed by the lower border of the third arch and the free arch-like margin of the lateral border of the neck which grows outward and forms an angle at the transition of the head into the chest. This groove was called the sinus præcervicalis by His and the sinus cervicalis by Rabl. The floor of this groove is formed by the fourth branchial cleft. In the embryo studied by Wenglowski the sinus cervicalis is formed by the third arch and the lateral wall of the neck. His and Rabl claimed that the second branchial arch formed part of the sinus, which would make it triangular with the third and fourth arches within it. Wenglowski claims that the second arch plays no part and that only the third branchial arch comes into consideration.

When viewing the branchial apparatus from within the pharynx, one sees the pharyngeal pouches and arches. (Fig. 5)

*The first pharyngeal arch*—This is massive and consists of three parts. They are two lateral portions and a medial portion. The lateral portions are semicircular. The medial arch is separated from the lateral elevations by two depressions. These elevations



narrow towards the front, and from the medial portion of the arch the body of the tongue is later formed. This pharyngeal arch corresponds with the branchial arch and runs parallel with it.

*The second pharyngeal arch*—This runs into the posterior pharyngeal wall, and in the mid-line is narrower and does not meet the opposite arch, as the so-called furcula lies between the ends. The direction of the pharyngeal arches is opposite to that of the outer branchial arches. The medial portions of the branchial arches are turned upwards, the pharyngeal arches downward. Thus they cross in the form of a letter "X". The second branchial arch is thicker laterally and thinner medially, while the pharyngeal arch is thinner laterally and thicker medially.

*The third pharyngeal arch*—This arch is shorter than the second. Its direction is horizontal and upwards, forming an "X" with the second pharyngeal arch. In the middle of the "X" is the furcula.

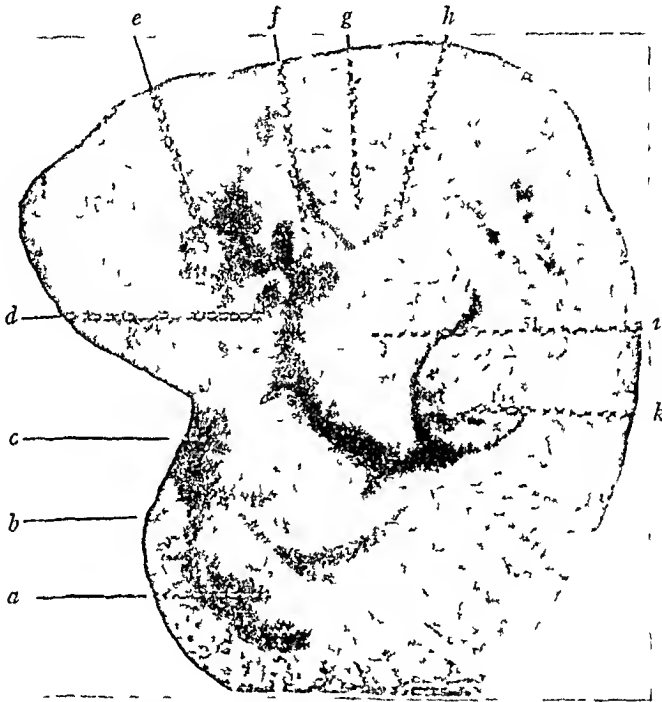


FIG. 3.—Lateral view of complete model of 6.5 millimetre embryo (Wenglowski). a—Lower extremity b—Tail c—Divided umbilical cord d—Nasal depression e—Eye f—Mandibular process of first branchial arch g—Second branchial arch h—Third branchial arch and sinus cervicalis i—Cardiac bulge k—Upper extremity

*The fourth pharyngeal arch*—This arch is shorter than the third, and wider than the fourth branchial arch. Its direction corresponds to the branchial arch, and its medial end goes into the furcula, where the same divides into two parts to form the entrance into the glottis.

The pharyngeal pouches are better developed but more complicated than the corresponding branchial clefts.

*The first pharyngeal pouch*—The lateral portion later goes to form the middle ear and the ear lobe. At one part the pouch and cleft are separated only by a thin membrane. This is near the anterior portion. The outer and medial portion separates the lateral portion of the tongue from the medial pharyngeal arch.

*The second pharyngeal pouch*—This pouch is separated from the second branchial cleft near the median portion, but they are close together at the lateral portion, separated only by a thin membrane. This pouch is deeper than the first pouch.

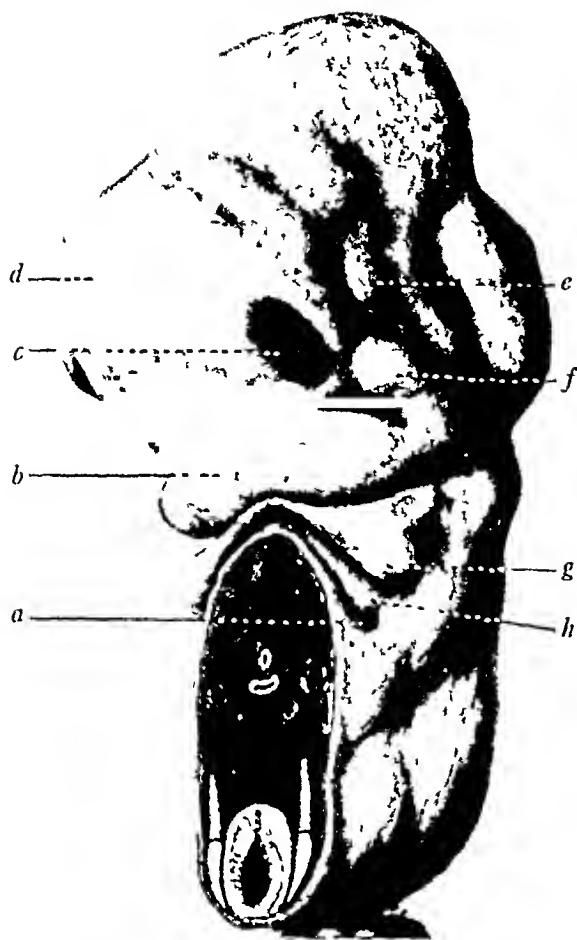


FIG 4



FIG 5

FIG 4—Head end of same embryo of 6.5 millimetres (Wenglowski) *a*—Sinus preceivialis *b*—Mandibular process of first branchial arch *c*—Nasal depression *d*—Nasofrontal process *e*—Eye *f*—Superior maxillary process of first branchial arch *g*—Second branchial arch with operculum *h*—Third branchial arch with operculum

FIG 5—Model of same embryo. Posterior portion of head and pharynx have been removed so that anterior pharyngeal wall is visible (Wenglowski) *a*—Oesophageal entrance *b*—Fourth pharyngeal pouch *c*—Third pharyngeal pouch *d*—Second pharyngeal pouch *e*—First pharyngeal pouch with anlage of tongue *f*—Medial process of tongue *g*—Lateral anlage of tongue *h*—Second pharyngeal arch *i*—Third pharyngeal arch *j*—Third pharyngeal pouch *k*—Entrance into glottis



FIG 6

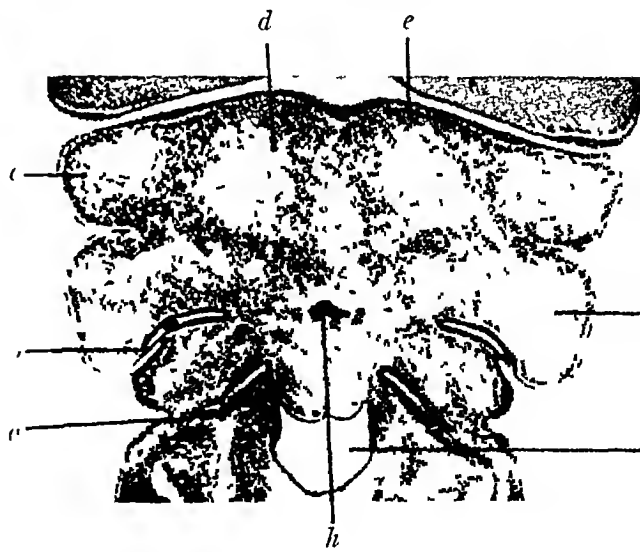


FIG 7

FIG 6—Microphotograph of cross section of same embryo above level of glottis (Wenglowski) *a*—Groove of precervical sinus and point of contact of epithelium of sinus and anlage of thymus *b*—Second branchial arch *c*—Anlage of thymus *d*—Epiglottis

FIG 7—Microphotograph of cross section through tongue and mid thyroid lobe anlage (Wenglowski) *a*—Closing membrane of third branchial cleft *b*—Closing membrane of second branchial cleft *c*—First branchial arch *d*—Right half of anlage of body of tongue *e*—Left half of anlage of body of tongue *f*—Second branchial arch *g*—Pharyngeal cavity *h*—Anlage of mid thyroid lobe

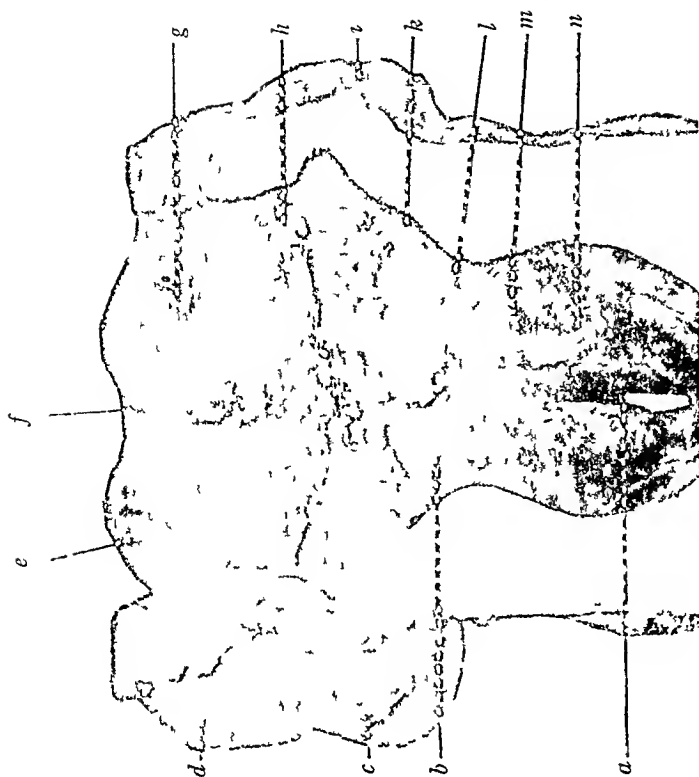


Fig. 9



Fig. 8

Fig. 8—Model of branchial apparatus of 8 millimetre embryo. The superior mandibular process of first arch and unsofrontal process have been removed. Some of chest wall has been removed (Wengowski). *a*—Esophagus *b*—Trachea *c*—Tip of tongue *d*—First branchial arch *e*—Second branchial arch *f*—Third branchial arch *g*—Fourth branchial arch *h*—Fifth branchial arch *i*—Lateral border of neck *j*—Entrance into glottis *k*—Lateral pharyngeal pouch *l*—Lateral anlage of tongue *m*—Lateral anlage of tongue *n*—Fourth pharyngeal arch *o*—Lateral pharyngeal pouch *p*—Third pharyngeal pouch *q*—Third pharyngeal pouch *r*—Third pharyngeal pouch *s*—Third pharyngeal pouch *t*—Third pharyngeal pouch *u*—Third pharyngeal pouch *v*—Third pharyngeal pouch *w*—Third pharyngeal pouch *x*—Third pharyngeal pouch *y*—Third pharyngeal pouch *z*—Third pharyngeal pouch

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*The third pharyngeal pouch*—This is twice as short as the second. It lies deeper and the lumen has an oval form.

*The fourth pharyngeal pouch*—This is longer and broader. The dividing membrane between the branchial cleft and the pharyngeal pouch is much thicker.

Microscopically, the branchial arches and the clefts are covered by squamous epithelium. The pharyngeal arches and pouches are covered by several layers of epithelium, in areas composed of ciliated epithelium. The second pouch is rarely ciliated, while in the third the cilia are predominant. In the third pharyngeal pouch where the thymus anlage is, the epithelium is squamous and distinctly hornified (Fig 6). In areas there is simple epithelium, and in other areas there is ciliated epithelium (Fig 7).

**EIGHT-MILLIMETRE EMBRYO**—Here the arches have developed into bigger and more massive structures and thereby the clefts are much narrower. On the left side there are six arches, while on the right there are only five. The second arch lies close to the third, and the third lies close to the chest wall, thereby narrowing the entrance into the sinus of the neck.

*The first branchial arch*—This consists of two parts, a medial and a lateral. From Fig 8 it is seen that it is quite complicated and one can see elevations and depressions, the anlagen of the lips and jaws.

*The second branchial arch*—This is more massive, especially in its lateral portion. From here it narrows and goes along the lower border of the first arch towards the mid-line where it goes over into the narrow portion and joins with the opposite second arch. At the angle of the two portions is an outgrowth called the operculum, which is, however, smaller than it was in the 6.5-millimetre embryo.

*The third branchial arch*—This arch is thicker and more massive. The lateral portion is short. The longer medial portion narrows gradually, and as it does not reach the mid-line it goes over into the lateral wall of the neck. The lower border of the third arch is pointed and forms the upper border of the entrance into the sinus of the neck.

*The fourth branchial arch*—This is covered by the third arch and almost invisible from the outside. It runs parallel to the third arch and is one-half its length. The medial end goes over into the lateral wall of the neck.

*The fifth branchial arch*—The fifth arch is better developed on the left side than on the right. It is in the shape of a three-cornered prism, where the base is on the lower wall of the sinus and the point is directed upwards.

*The sixth branchial arch*—This arch is present in the embryo only on the left side. It is situated at the transition of the lower and anterior walls of the sinus.

In the region of the first to the fourth branchial arches the branchial apparatus is converging. From the fourth to the sixth arches it is diverging.

The branchial clefts on the whole are similar, but the entrance into the cleft is crowded downwards on account of the growth of the lateral portions of the arches.

*The first branchial cleft*—In the posterior portion of this cleft is the external auditory canal which in the meantime has developed and is actually separated from the cleft by a small process.

*The second branchial cleft*—This cleft has a deep pocket on the left side posteriorly and is separated from the pharyngeal pouch by an oval membrane. On the right side the cleft is equally deep throughout.

*The third branchial cleft*—This cleft is longer on the right side than on the left. It occupies the rest of the sinus. On the right side is a deep pocket which ends with an oval small membrane. On the left side it is more shallow and also ends in a membrane with an interposed thicker mesenchyme layer.

*The fourth branchial cleft*—This cleft is shallow and is separated from the pharyngeal pouch by a thick mesenchyme layer.

The sinus cervicalis is deeper and larger. The entrance is narrower, not triangular, but elongated and oval. The upper border of the entrance is formed by the lower border

of the third branchial arch. The anterior portion and lower margin are formed by the lateral regions of the neck and the anterior portion of the chest wall. The cavity of the sinus is taken up by the fourth, fifth and sixth arches and clefts. The deepest part corresponds to the upper median pocket of the third branchial cleft. The next deepest portion is the floor of the fourth cleft. The posterior wall is composed of the posterior end of the fourth arch and cleft. The upper wall is the lower surface of the third arch and the floor of the third cleft. The medial wall is mainly the base of the fourth arch, the floor of the fourth cleft and the medial end of the fifth arch. The anterior wall is formed by the lateral wall of the neck, and the lower wall, or the floor of the sinus, is formed by the fifth and sixth arches and clefts.

Seen from within it is much the same as in the 6.5-millimetre embryo (Fig. 9).

*The first pharyngeal arch*—The anlage of the tongue is much more distinct and is

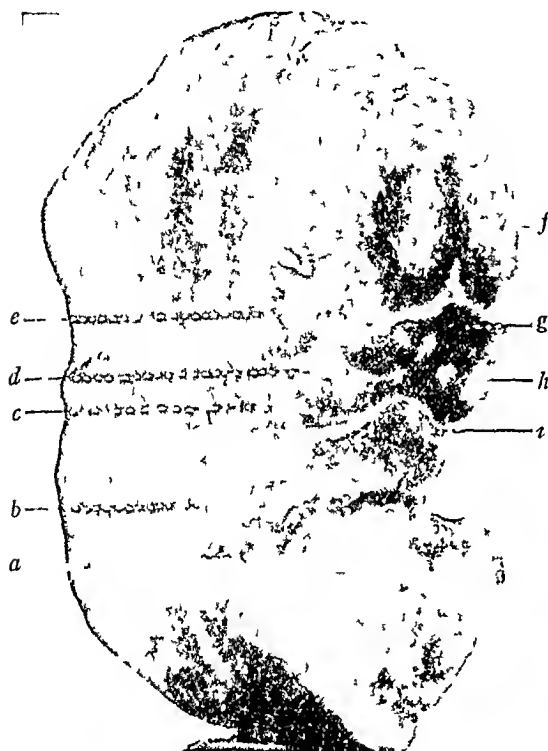


FIG 10

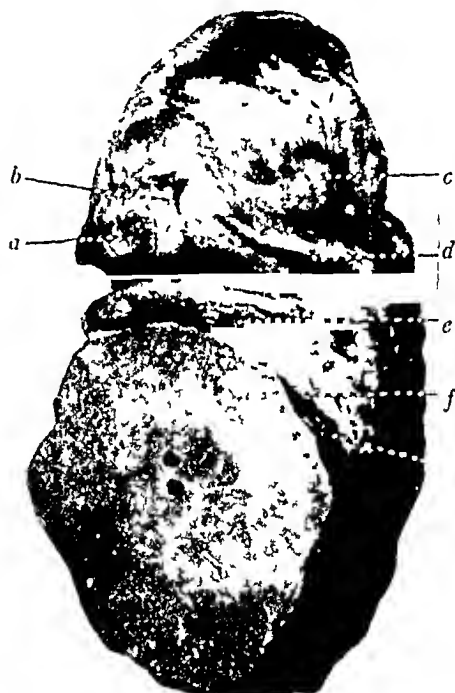


FIG 11

FIG 10—Model of head of 11 millimetre embryo. Anterior view. Anterior chest wall removed (Wenglowski). a—Third branchial arch b—Second branchial arch c—Lateral portion of upper lip d—Superior maxillary process e—Eye f—Frontal process g—Nose h—Anlage median portion of upper lip i—Mandibular process

FIG 11—Model anterior head portion 13-14 millimetre embryo. Chest and posterior head portion removed (Wenglowski). a—Anlage mid portion upper lip b—Nose c—Eye d—Lateral portion upper lip e—Mandibular process first branchial arch f—Second branchial arch g—Angular curve of neck

composed of two portions. A lengthened medial process is seen in the medial portion of the tongue.

*The second pharyngeal arch*—This arch is much thicker and shorter, but otherwise the same as before.

*The third pharyngeal arch*—This is conical and the lateral end is wider and bent downwards. The medial end joins with the rounded body, namely, the furcula of His. It is more massive than the corresponding arch.

*The fourth pharyngeal arch*—This is short and thick and corresponds to the branchial arch, but is heavier and thicker. Mesially it ends in the furcula.

## NECK CYSTS AND FISTULÆ

The fifth and sixth pharyngeal arches are not to be seen

*The first pharyngeal pouch*—This is a small flat depression between the anterior anlage of the tongue and the second pharyngeal arch

*The second pharyngeal pouch*—This is narrower. Its median portion becomes wider and deeper. Where the pouch meets the pharyngeal wall it turns downward at right angles and ends in a thin closing membrane in the depth

*The third pharyngeal pouch*—This is oval at its opening but gets wider as it gets deeper, so that it is much wider at the bottom than at the entrance. In the lateral portion is a closing membrane. In the posterior lower wall is a process running downward and forward—the thymus anlage

*The fourth pharyngeal pouch*—This has an oval entrance with a wide base. The mesial portion of the floor is taken up by a deep canal, passing forward—the anlage of the lateral thyroid lobes

The furcula is shorter and more massive

Microscopically, there are islands of ciliated epithelium in the pouches, especially in the thymus and thyroid canals

ELFVEN-MILLIMETRE EMBRYO—Here the branchial apparatus is in the process of retrogression. The sinus is closed from without so that only three arches are visible (Fig 10)

*The first arch* is markedly changed and development of the lower lip anlage and lower jaw anlage is marked

*The second arch* is quite large, and still conical in shape. Its lateral portion is thicker than the medial portion, and the medial portion joins with the opposite side in a narrow strand

*The third arch* is not big. It is parallel to the second arch. Its anterior end narrows and passes and disappears into the antero-lateral wall of the neck. The lower border of the third arch has joined the upper lateral wall of the neck throughout its entire length and displaces the entrance into the sinus

The branchial clefts are flat and shallow. In the middle of the right third cleft is a narrow passage entering a wide cavity, the remains of the sinus cervicalis. On the left side this canal is not to be found

Seen from within one notes that the retrogression of the apparatus has progressed markedly. The pharyngeal arches melt one into the other and the pharyngeal pouches are shallower. The tongue takes on a real form, although the body and the base of the tongue are still separate. The base of the tongue consists of two processes joining in the mid-line. These processes are the medial ends of the second and third pharyngeal arches. The lateral ends of these arches pass on to the lateral pharyngeal walls and form the anlage of the alveolar processes. The epiglottis is wide and not well shaped. The anlage of the arytenoid cartilages is noticeable. In the posterior portion of the third pharyngeal pouch are small canals—the thymus canals

TWELVE- TO THIRTEEN-MILLIMETRE EMBRYO—Further retrogression is noticeable (Fig 11). Only the first and second arches are to be seen. A small depression marks the point of the now absent sinus. The first arch is well differentiated, the second still conical and now horizontal. Its medial ends have joined with the wall of the neck. Due to the displacement of the heart downward the contours of the neck slowly appear

Seen from within, marked changes have occurred. The pharyngeal arches are low, their contours confluent, and the pouches small shallow grooves (Fig 12). The second and third arches are still to be made out (differentiated), but laterally form the alveolar arches and mesially go to form the tongue. Microscopically, a small cyst is to be seen, the rest of the second cleft, within the mesenchyme, lined with several layers of epithelium. In the sections through the sinus cervicalis region an oval hollow space is seen on the right side lined with squamous epithelium, connecting with the outer world through a narrow canal. On the left side only a small cyst lined with epithelium and surrounded by mesenchyme is to be seen

FOURTEEN-MILLIMETRE EMBRYO—Here there is no evidence of the branchial apparatus. Two small, lengthened processes below the lower jaw take the place of the second branchial arch. The neck is more developed.

Seen from within, the tongue is already well formed, but two transverse folds are to be seen near the base, the remains of the second and third arches (Fig 13). The epiglottis and arytenoids are better developed. Two small, rounded canal openings are visible where the third pharyngeal arch passes over on to the lateral pharyngeal wall posteriorly. These are the thymus anlagen.

NINETEEN-MILLIMETRE EMBRYO—No remains of the second arch are to be seen. The neck is better developed and longer. The contours of the neck muscles are to be made out. From within, the well-formed tongue and alveolar arches are to be seen. The epiglottis is separated from the tongue by a depression (Fig 14).

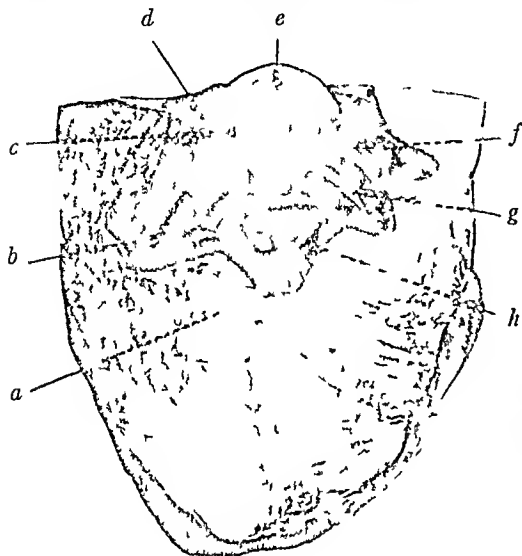


FIG 12



FIG 13

FIG 12—Same model seen from within. Anterior pharyngeal wall (Wenglowski). a—Uso phageal entrance b—Epiglottis c—Foramen cecum d—Alveolar process e—Tongue f—Second pharyngeal arch g—Third pharyngeal arch h—Arytenoid cartilage.

FIG 13—Model of head end of 14 millimetre embryo. Posterior view. Anterior pharyngeal wall visible (Wenglowski). a—Entrance into glottis b—Foramen cecum c—Nasal septum d—Choanae e—Tongue f—Epiglottis.

Comment—From the above findings it is seen that the beginning of the development of the branchial apparatus in the human embryo takes place in the second half of the first month. In the course of the second month already, sometimes even in the first half, the branchial apparatus completely disappears. Therefore, its existence in the human being is short, and it does not last more than one month. In the early stages as the heart descends the medial ends of the first arch are near each other. These form the lower border of the primary mouth cavity. The second arches are separated, the third more, and the fourth even more. This forms a triangle with the apex at the mid-portion of the first arch. This triangle is occupied by the heart. From within, an area is formed free of arches, called the mesobranchial field. In this area an elongated, oval, fairly large, bent body is found, with its convexity posterior. This is called the furcula. From it the medial portion of the base of the tongue and the epiglottis develop, and from its lower

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portion the glottis itself. During the further growth the arches grow and tend to meet in the mid-line. According to His the branchial clefts and pharyngeal pouches coincide in their direction throughout their length and are separated by a thin membrane. This Wenglowksi considers an error. In sagittal sections by His, as found in nearly all text-books, it is shown that the convexity of the branchial arch coincides with that of the pharyngeal arch, and the concavity of the branchial cleft with that of the pharyngeal pouch. In reality Wenglowksi claims this does not occur in the human being, and is only faintly indicated in the three-millimetric embryo where the

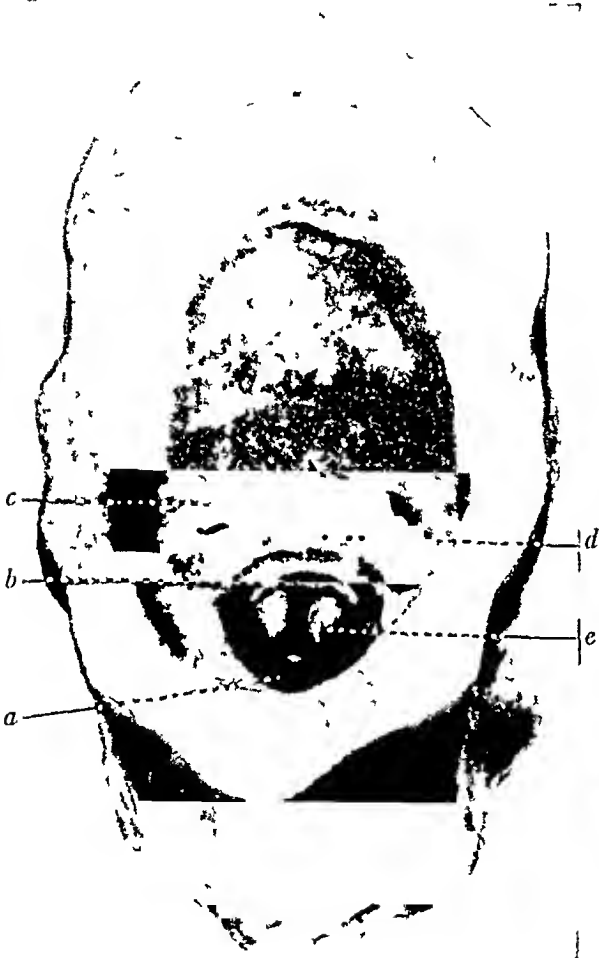


FIG 14



FIG 15

FIG 14—Model head end of 20 millimetre embryo. Seen from within (Wenglowksi) *a*—Pharyngeal entrance *b*—Epiglottis *c*—Mouth cavity *d*—Foramen cæum *e*—Arytenoid cartilage

FIG 15—Author's case of bilateral branchiogenic cysts developing into fistulæ in the ear lobes and preauricular region of the first branchial cleft. The left side had been operated upon before patient came under author's care. Careful dissection and total removal cured the condition. During convalescence the right side suddenly enlarged and had to be operated upon.

apparatus is exceedingly simple and early in development. In the later stages each branchial arch and cleft crosses the pharyngeal arch and pouch. This is caused by the fact that the mesial end of the branchial arches and clefts run forward and upward and orally, while the pharyngeal arches and pouches run posterior and downward and aborally. The bottoms of the clefts and pouches run in different directions as described above in detail, and therefore are in contact only for very small areas where small occluding



membranes are present. The contact point between the clefts and pouches of all the four clefts occurs in the lateral portions. Therefore, the occluding membranes occur in the lateral portions of the clefts. The largest occluding membrane is present in the second cleft.

Wenglowski did not notice a perforation of this membrane in a single well-preserved embryo. The membrane consists of an outer epithelial layer and an inner one with a small amount of interposed mesenchyme. The second and third membranes are thinner, the first thicker, and the fourth still thicker. As the branchial apparatus develops, the membranes get thinner, and are thinnest in the six-millimetre embryo. The retrogression begins in the eight- to nine-millimetre embryo. According to His's theory, the arches disappear due to the thickening of the membranes, which push the clefts from the pouches. This Wenglowski contradicts by showing in what small areas only the membrane is present between the cleft and the pouch. The disappearance of the clefts is caused by two factors: first, by the ingrowth of mesenchyme, and second, by the growth of the arches themselves. The arches grow closer and closer together and thereby narrow the clefts more and more until they finally disappear. This disappearance may be due, first, to the displacement of the epithelium outward by mesenchymal growth, and then again may be due to the adhesion and obliteration of epithelial surfaces in contact. This is best seen in the disappearance of the sinus cervicalis. That the clefts disappear by adhesion and obliteration may be seen from the fact that microscopically one sees epithelial rests surrounded by mesenchyme in the region of the clefts.

It is accepted nowadays that the following structures develop from the following clefts and arches: First cleft—external auditory canal and ear lobe, Second cleft—tonsillar fossa, Third cleft—thymus, Fourth cleft—lateral lobes of the thyroid. First arch—lateral portion of the upper lip, upper jaw, lower lip and lower jaw, and body of the tongue, Second arch—body of the hyoid bone, stylohyoid ligament and muscle, anterior portion of the base of the tongue, arcus palatoglossus, Third arch—greater cornu of the hyoid bone, posterior portion of the base of the tongue, arcus palatopharyngeus, Fourth, Fifth, and Sixth arches—development of the soft parts in the region of the greater cornu of the hyoid bone. (Fig 15)

The position of the entire branchial apparatus in the earlier stages, as well as the localization of the final rests, point to the fact that it belongs more to the head than to the neck region. In the embryo shown in Fig 3, the branchial apparatus runs in the vertical position of the body from in front backward and from below upward. In the adult the entire apparatus groups itself, or, better, it rests along the lower jaw and around the hyoid and its cornu. In other words, the direction remains the same as in the embryo. The lower border of the hyoid forms the lower border of all the remains of the branchial apparatus, and nothing below this line has any genetic connection with the branchial apparatus. In spite of the fact that it seems that the branchial apparatus occupies the entire neck in young

embryos, and changes its position as seen in Figs 3 and 4, in reality the apparatus, with the exception of the first and second arches, does not change its position. The massive nasofrontal process shortens and decreases in size rapidly. The head of the embryo is lifted by the rapid growth and rounding of the head. The lower jaw is lifted somewhat and passes more anteriorly at which time the heart descends, so that one sees all the facial outlines indicated, the lower jaw appears, and the remains of the second, third and fourth arches run backward and somewhat downward, and not only downward as they appear in Fig 4. The neck is in its early development. Of course the development of the neck below the hyoid is of importance, as the development above the hyoid occurs at the same time as that of the branchial apparatus.

At first the region above the hyoid is large and that below the hyoid is absent and right between the second arch and the heart the anterior chest wall will appear. During further development the portion above the hyoid remains almost unchanged. The portion below the hyoid lengthens as the heart descends. The branchial apparatus, however, can influence only the upper neck region, as its position is sharply demarcated by a line drawn through the hyoid bone.

In other words, all congenital anomalies caused by incomplete retrogression of the branchial apparatus *must* be located in the region above the lower border of the hyoid bone.

This means that almost all congenital anomalies of the neck are *not* the result of the branchial apparatus, but come from other factors, even though they may have originated from this apparatus.

#### THE DEVELOPMENT OF THE THYMUS

In 1831, Arnold found in an eight-weeks embryo two passages on either side of the trachea which he interpreted as belonging to the thymus. Koelliker believed that the thymus developed from the second cleft. In 1881, Stieda stated from experiments on sheep and pig embryos that the thymus developed from the third or the fourth cleft.

His at first believed that it came from the second, third and fourth pharyngeal pouches. He later changed his mind and in 1886 stated that it came from the depth of the sinus cervicalis, and again in 1889 changed his opinion, believing that it came from the branchial cleft.

In 1883, Born showed in a pig embryo that the thymus developed from the posterior portion of the third pharyngeal pouch. Hammar found no evidence of the thymus in a three- to five-millimetre embryo. In the eight-millimetre embryo he found in the corner of the third pharyngeal pouch a pocket running downward and medially, converging with that of the opposite side. He published a picture of an 18.5-millimetre embryo in Kollmann's Atlas, in which he showed the thymus as a long strand running alongside the pharynx and the œsophagus. The upper gland portion was thickened and from the upper end of the thymus a narrow strand passed upward indicating a connection with the pharynx. This is the thymo-pharyngeal duct. The entire thymus looks like an even cylindrical duct passing downward with a thickening at the end, the lower ends close together in a converging fashion.

In 1912, Wenglowski published his findings about the thymus which he studied in serial sections and wax model reconstructions of the human pharynx, trachea, and organs branching from these.

*Six-and-five-tenths-millimetric Embryo*—The third branchial pouch is well developed. It is in close contact in its lateral and partial lower wall with the epithelium of the third branchial cleft. In the lateral portion of this pocket on the lower wall a bag-like depression passes downward and somewhat laterally. In the model one sees that from the lowermost portion and from the lateral wall of the fourth pouch two large processes pass forward. These are the anlagen of the lateral thyroid lobes (Fig 16).

Somewhat more forward and lateral to these is the third branchial pouch, which laterally passes into the third cleft. From the angle of this pouch a bag-like depression arises somewhat downward and posterior, and appears to cross the thyroid anlage. This is the thymus anlage.

Microscopically, one finds that the epithelium of this pouch is so closely in contact with the epithelium of the cleft that one cannot differentiate it. At the medial end one

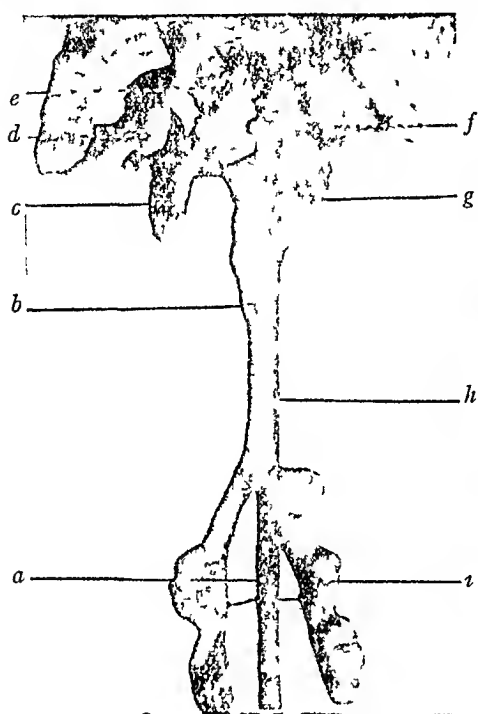


FIG 16



FIG 17

FIG 16—Model of esophageal lumen and branchial apparatus of 6.5 millimetre embryo. Model straightened for greater clearness (Wenglowski). a—Thymus anlage b—Esophagus c—Lateral thyroid lobes d—Thymus anlage e—Mid thyroid anlage f—Thymus anlage g—Lateral thyroid anlage h—Esophagus i—Left lung anlage

FIG 17—Model of pharynx, esophagus, trachea and organs developing from them in 7.14 millimetre embryo (Wenglowski). a—Thymus b—Esophagus c—Thymus duct d—Mid thyroid lobe e—Lateral thyroid lobe f—Thymus duct g—Pharynx h—Thyroglossal tract i—Thymus duct k—Lateral thyroid lobe duct l—Lateral thyroid lobe m—Thymus lobe n—Trachea o—Thymus

notices a thickening of the epithelium from which a pouch passes downward into the mesenchyme. On the lateral wall are several layers of flat epithelium, while on the medial wall is ciliated epithelium. (See Fig 6)

*Eight-millimetric Embryo*—Here the thymus anlage is more developed. It passes downward and posteriorly, crossing the thyroid anlage. Microscopically, the hollow thymus anlage connects only with the pharynx through the mesial end of the third pharyngeal pouch. A narrow canal goes from the wall of the pharynx, in the region of the third pouch, laterally, and is in close contact with the epithelium of the sinus. It then bends at right angles and passes medially and posteriorly. In this manner the thymus anlage communicates with the pharynx through a very complicated angulated

## NECK CYSTS AND FISTULÆ

canal whose angle closely touches the epithelium of the sinus. This angulated form is important and this type is seen and explains certain types of pathological findings. The posterior lateral wall of the thymus anlage is thicker than in the previous embryo, and grows into the mesenchyme in irregular fashion. The anlage lumen is lined with stratified squamous epithelium, but ciliated epithelium is also found, especially above the angulation.

*Twelve- to Thirteen-millimetric Embryo*—The thymus is well developed. It is a long strand with two limbs, thickened at its lower end. The upper short limb passes downward in the space between the lateral ends of the third and fourth arches. It lies closer to the third arch, and at the point where this curves onto the lateral pharyngeal wall it forms a fold, later the arcus palatopharyngeus. From here the upper limb passes almost horizontally outward and downward and comes very close to the outer skin of the neck. Here on both sides the thymus anlage lies close to the remaining little cysts, remainders of the sinus cervicalis of the neck. These little cysts are behind and lateral to the thymus anlage. Here the thymus anlage becomes angulated and at a right angle passes into the lower limb, which runs downward, forward and medially. The lower end is thickened irregularly. The entrance of the anlage into the pharynx is slightly anterior to the anlage of the lateral lobes of the thyroid. From here it crosses the thyroid and passes onto the outer posterior surface of the same and follows it. The thickened ends pass down below the thyroid anlage.

The thymus anlage has a lumen throughout, situated near the anterior wall of the anlage. Only at the lower thickened end is this lumen absent. The lumen is semilunar in shape with its convexity postero-lateral and lined with flat epithelium. Here and there are islands of ciliated epithelium. At the lowest end the epithelium changes into round-cell masses. The thymus canal enters the lateral pharyngeal wall in the third pharyngeal arch where the latter curves upward over the base of the tongue.

*Fourteen-millimetric Embryo*—Here the thymus is at its greatest development. All parts are still present. There are two limbs, one the short horizontal portion, and one the long strand, which is vertical. The angle between the two limbs is much less acute and much more rounded. The vertical portion is very long and equally thick, and follows the lateral border of the thyroid lobe. It passes down below the thyroid and the lower ends of the two sides almost join in the mid-line. On the right side is a narrow lumen throughout the extent, while on the left side there is a lumen only in the upper and middle third, without an opening into the pharynx. Small cysts are to be seen microscopically, lined with ciliated epithelium. On the left side no lumen is to be found microscopically between the upper and middle thirds. The canals enter the pharynx at the posterior border of the third pharyngeal arch where this passes from the lateral surface of the tongue onto the lateral wall of the pharynx. The upper third of the lumen is lined with ciliated epithelium. Below this is squamous epithelium with islands of ciliated epithelium. (Fig. 17.)

*Sixteen-millimetric Embryo*—Two changes have taken place. The lower end takes on the form of a gland. At the same time retrogression takes place at the upper portion of the anlage. As seen in the model, the strand is divided into several divisions. At the anlage near the pharynx a conical process remains behind at the posterior end of the third pharyngeal pouch. This rest is lined with polyhedral epithelial cells, and at the anterior wall is a narrow lumen which almost reaches the pharynx. Near the pharynx there is squamous epithelium. Further away there is ciliated epithelium. Then there is an interval, and behind the thyroid lobe it again appears and ends in a dilated end. The rest near the pharynx is entirely missing on the right side, and the anlage begins only behind the lateral lobe of the thyroid. The lumen is present only on the right side in certain areas, and on the left side is not completely present any more. Some little

cysts are present lined with ciliated epithelium. The lumen near the anlage is still semilunar in shape. This is caused by an ingrowth of cells into the lumen which presses it against the wall of the canal. The direction is still the same, downward and forward, on one side along the dorso-lateral border of the thyroid, and on the other side along the anterior border of the sternocleidomastoid down to the sternum (Figs 18, 19)

*Nineteen- to Twenty-millimetre Embryo*—Retrogression is more advanced. On the reconstruction model the upper and lower ends have a different appearance. The lower end is knobbed, irregular and thickened. The upper end is even, cylindrical and strand-like. The left side is distended from the upper border of the thyroid to the sternum. It is smooth and only in its upper third is it indented. Inside is a flattened canal throughout its length. On the right side the upper half is absent, and the anlage begins at the upper end of the thyroid and runs downward into the gland substance. The cylindrical portion has a canal throughout. Cross-section shows two thymus canals, unlike in size, lined with ciliated epithelium, with a thin dorsal wall and a thickened ventral wall. In other areas stratified flat epithelium is present. The course and direction are typical. The

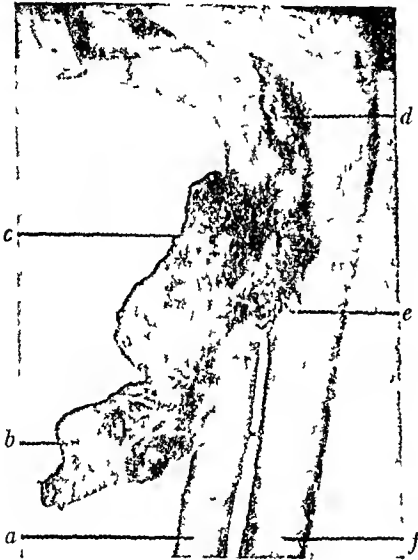


FIG 18

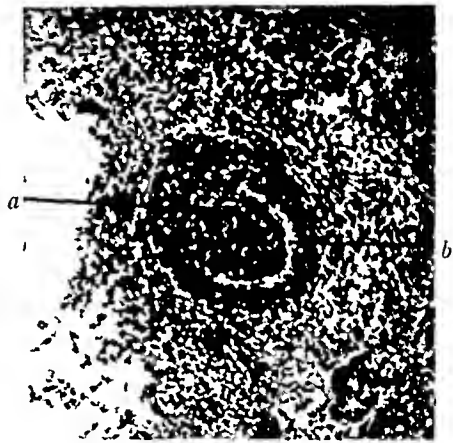


FIG 19

FIG 18—Lateral view of model of pharynx, cesophagus and organs developing from same in 16 millimetre embryo (Wenglowski) a—Trachea b—Thymus c—Thyroid d—Rest of upper portion of thymus duct e—Thymus duct f—Cesophagus  
FIG 19—Microphotograph of cross section through the thymus duct in 16 millimetre embryo (Wenglowski) a—Ingrowth of glandular cells into lumen b—Lumen of thymus duct

lower end lies in the upper portion of the chest cavity. In the retrogression process a certain orderly fashion occurs. The uppermost portion disappears first, and from there on the retrogression passes downward. It is unusual to find thymus rests near the pharynx in two- to three-months embryos. Dorsal to the lateral lobes of the thyroid and below rests are frequently seen (Figs 20, 21)

These rests have a fairly regular histology. In the centre or near the ends are hollow spaces lined by either squamous or ciliated epithelium, or both. Outside of this lymphoid cells are often found. The nearer the pharynx the more frequently ciliated cells are found. The nearer the sternum the more frequently squamous epithelium is found.

The thymus develops later than the medial and lateral thyroid lobe anlagen. It is first seen in a 6.5-millimetre embryo. It is due to the close

## NECK CYSTS AND FISTULÆ

proximity of the thymus anlage to the epithelium of the sinus cervicalis that His believed that the thymus originated from the sinus, while Wenglowski shows that it develops from the third pharyngeal pouch

Pierson, Piennant and Hammar confirmed the close association between the sinus epithelium and the thymus anlage. The thymus canal between the sinus and the lateral wall of the neck is lined with ciliated epithelium. The pharyngeal opening and further down is lined by squamous epithelium. The walls below the angle are irregularly thickened and the cells take on lymphoid characteristics. The canal reaches the level of the sternum. Below this the gland develops without a canal and lies anterior to the great vessels within the chest.

If the thymus anlage did not retrogress it would go from the pharynx laterally and slightly downward to the area between the angle of the jaw and the ear lobe. From here it passes downward and forward and medially, lying close to the lateral border of the thyroid gland and medial to the border of the sternomastoid muscle, down to the sternum where it passes into the actual gland substance.

This complete structure rarely occurs later in life, and in embryos only until the second or third month. The neck portion totally disappears. Sometimes it does not completely disappear and segments



FIG. 20.—Lateral view of model of pharynx, œsophagus, trachea and organs developing from the same in 20 millimetre embryo (Wenglowski). a—œsophagus b—Thymus duct c—Rest of upper end of thymus duct d—Glottis e—Lateral thyroid lobe f—Mid thyroid lobe g—Trachea h—Thymus

may persist during life and not cause any trouble. The lower portion persists more frequently than the upper, and very rarely the portion close to the pharynx. It has also been definitely established that if rests are still present at the third to fourth months of embryonic life, they will persist throughout life in a latent condition.

Wenglowski examined the neck of ten adult bodies by careful dissection, with microscopical examinations of all suspicious tissues. He also examined

the bodies of sixty-five infants and did serial sections of the necks. Of the adults two cases were found with thymus anlage rests—some cysts lined with ciliated epithelium and lymphoid tissue in the walls. Of the sixty-five infant bodies rests were found in the serial sections twenty-one times. Twelve times they were found in the lower half of the neck, measuring the half on the sternomastoid muscle, and seven times in the upper half, and twice close to the pharynx.

Histologically, these rests are small canals or cysts, frequently with squamous epithelium, sometimes ciliated and sometimes mixed. The walls are lymphoid in character, similar to the thymus. Hassal's bodies are sometimes found, usually when in the lower half of the neck. In two cases close

to the pharynx there were cysts, cylindrical to the point close to the posterior tonsillar fossa, with clear content and mucous glands in the wall, with ciliated epithelium in the lining.

Thus we see that a complete canal can persist in the adult and cause pathology early. Also, this canal can be divided into segments. Close to the pharynx mucous glands can be present in the wall, torn off from the epithelium of the pharynx just the same as in the middle thyroid anlage, but they are not carried into the depth as the anlage is in the bottom of the third pouch and not from the lateral wall of the pharynx.

With careful observation Wenglowski found thymus rests at the time of surgical operation upon thyroid conditions and other neck conditions, which microscopically were proven to be

thymus tissue.

*The Development of the Lateral Thyroid Lobes*—Born demonstrated by means of the reconstruction models that the lateral lobes of the thyroid come from a different anlage than the median lobes. He stated that the anlage of the lateral lobes was to be found in the fourth pharyngeal pouch. Wenglowski found no evidence of an anlage in an embryo of three millimetres. In a 6.5-millimetre embryo there is evidence. The anlage is conical, narrow below and broad at the attachment to the fourth pouch. Its direction is forward and somewhat downward. Microscopically, there is a lumen lined with several layers of epithelium with proliferation of the cells in the wall distal to the pharynx. The lateral lobes grow downward and forward and approach the median lobe.

In an eight-millimetre embryo the anlage is bigger and more prism-like, wider and bigger below and more narrowed above at the pharynx. The lumen is narrowed above and somewhat wider below, but not as large as in the 6.5-millimetre embryo.

In the fourteen-millimetre embryo the attachment to the pharynx is only by a narrow, thin strand. The lobes widen and thicken below and go to meet the median lobe.

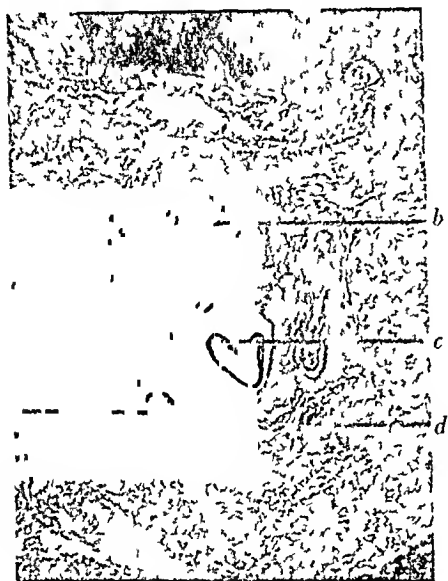


FIG. 21.—Microphotograph of cross section of neck of 20 millimetre embryo (Wenglowski).  
a—Thymus duct b—Esophagus c—Trachea  
d—Thymus duct

## NECK CYSTS AND FISTULÆ

Microscopically, on the left side a small canal is seen connecting with the pharynx. On the right side the canal is obliterated and replaced by cells.

In the sixteen-millimetre and nineteen-millimetre embryos the lateral lobes of the thyroid are completely separated from the lateral pharyngeal wall. The primary canals and its rests have completely disappeared. The gland descends downward and becomes a unit with the middle lobe. In older embryos and in autopsy material the canals were never found to persist. However, accessory thyroid tissue was found between the tips of the lateral lobes and the situation of the anlage at the pharynx. Occasionally one finds thyroid tissue in the outer wall of the œsophagus which has been dragged there and imbedded by the rapid growth of the œsophageal musculature.

Thus the lateral lobes of the thyroid develop earlier than the thymus. In the 6.5-millimetre embryo the lateral lobes of the thyroid are well developed while there is no evidence of the thymus. The thyroid lobes develop from the epithelial pocket in the floor of the fourth pharyngeal pouch. The lobes grow downward and inward and become a firm unit with the median lobe. They take on typical thyroid structure histologically, and lose the lumen which is present in the anlage. They completely separate from the pharyngeal wall.

Theoretically the lumen or segments of it might persist, but in 150 autopsies Wenglowski did not find it a single time. Abnormally placed thyroid tissue with pathology is the only condition which can be related to the anlage of the lateral lobes of the thyroid.

*Clinical Observations*—Kostaniecki and Milecki accepted the branchial theory. Many cases were described that could not be explained, however, by the branchial theory, and not a single one that in its entirety could be attributed to the second branchial cleft. The relation with the glossopharyngeal nerve was considered as very important, and therefore etiologically it was attributed to the second cleft, but in many cases (Karewski) there were no relations for proximity of the lateral tract with the nerve and the fistula.

Watson, Karewski and Hildebrand, *etc*, showed that the fistula passed below the stylopharyngeal muscle and usually passed downward at the posterior border of this muscle. This muscle is an important landmark of the third branchial arch. The direction and position of the muscles are as constant as of the nerves and blood-vessels which Kostaniecki and Milecki accepted as the constant findings. They did not take the muscles as a constant finding. In reality the muscles and nerves are more constant than the vessels.

Microscopically, the finding of ciliated epithelium and also squamous epithelium in the wall of a complete or incomplete fistula speaks against the perforation of the closing membrane, with the accepted theory (Kostaniecki and Milecki) that the pharyngeal pouch is lined with ciliated epithelium and the branchial cleft with squamous epithelium.

In other words, it was necessary to juggle anatomical findings in order to explain histological findings in these fistulæ and cysts. The theory of Rabl and his duct cannot explain the fistulæ with openings near the sternum, and His's theory of the second branchial cleft taking part in the sinus cervicalis and the latter then breaking through to the outside must of necessity confine the external opening by the location of the sinus. This is fixed by the third and fourth branchial arches at the dorso-lateral border of the hyoid.



Lower than this the sinus cannot go because it would be prevented by the arch which is fixated at this point

Kostaniecki and Milecki's theory of the second cleft did state that the inner opening was often in the region of the posterior tonsillar fossa, and it made them think of the possibility of the third pouch as the origin. However, they discarded this theory, as the third pouch is small, and they stated that the lateral fistula had no relation to the thymus. The outer opening, according to Kostaniecki and Milecki, was dependent on the perforation of the closing membrane and the degree of infection. In reality there is a definite and constant finding of the outer opening along the anterior border of the sternomastoid muscle and in the angle of the latter and the sternothyroid and sternohyoid muscles.

The course of the complete fistula is also always a constant one, namely, arched. The arch is always constant below the angle of the jaw about the middle of the posterior belly of the digastric muscle. From here the upper portion goes inward and upward and the lower portion downward and inward along the medial border of the sternomastoid muscle. If one examines the direction of the second branchial cleft and pharyngeal pouch one does not find any likeness to the direction of the course of the fistula.

The relation to the carotid vessels is also of interest. As the external carotid is the axis of the third branchial arch, then the second branchial cleft would have to pass between the external and the internal carotid arteries to open externally. In reality, the fistula does not pass through this space but lies anterior and close to the sheath of these vessels, and from there goes in the direction of the pharynx.

Therefore, to explain the lateral cysts and fistulae by the branchial theory is so artificial and shows so many erroneous conclusions that it seems we all ought to agree with Wenglowski and once and for all discard the branchial theory as the etiological factor, and stop calling these conditions branchio-genetic cysts and fistulae. All cysts or fistulae above the hyoid level might come from the branchial apparatus. Everything below this level must come from other sources. Anatomically, it seems impossible to think of the possible persistence of a cleft beyond the second embryological month. A cyst resulting from it is possible during the first or second embryological month, but not easy to imagine in adult life. The branchial structures obliterate so thoroughly that a complete fistula is not easy to imagine with the breaking through of a cleft to the outside. It is possible to imagine epithelial rests but a complete fistula from a cleft is difficult to understand after the second embryological month. After that, in adult life, clefts cannot exist as the surrounding tissues continuously grow closer and closer together.

The thymopharyngeal duct, however, will explain all the clinical findings. Its course is exactly that of the findings in a patient. Around the arch of the duct are the sinus rests. Above the arch the duct forms a part of the third pharyngeal pouch. Below the arch it forms a part of the actual thymus duct.

A duct with an inner opening soon infects itself and usually breaks through to the outside early, and then a cyst changes into a fistula

Microscopically, the fistulæ and cysts coincide with the thymus anlage findings. One finds areas with stratified squamous epithelium mixed with ciliated epithelium, and in the walls encysted striated muscle fibres, cartilage and mucous glands. Lymphoid tissue is also present in large amounts which is not found in the mid-line ducts or cysts, but is found in thymus tissue and thymus ducts.

The etiology of mid-line and lateral cysts and fistulæ is different insofar as the mid-line are epithelial rests dragged in by the mid-thyroid anlage, which has no duct, and are not from the anlage itself. The anlage grows rapidly from the floor of the mouth as a solid strand and drags in the surrounding structures, while the thymus anlage grows from the depth of the third pharyngeal pouch outside the pharynx, and does not grow as a solid strand but as a depression which later changes into a canal.

While the mid-thyroid anlage leaves behind it the foramen cæcum, the thymus anlage leaves no mark behind as the third pharyngeal pouch completely obliterates.

One often sees complete lateral fistulæ, but complete median fistulæ do not exist.

It makes no difference where a thymus-duct cyst breaks through to the outside—either near the pharynx or near the sternum along the sternomastoid—the course of the thymus duct always remains the same.

Virchow and Koenig had a case which they could not explain by Wenglowski's theory. Wenglowski, however, does explain the cases as being a combination of a thymus duct and an additional abnormal external ear into which the thymus duct perforated due to infection, in addition to the external opening.

Koenig also had a case in which the internal opening was in the glottis. The question is whether this case was due to secondary internal perforation following inflammation and repeated operations, or whether it was primary and due to a persistent anlage duct of the lateral lobe of the thyroid which would enter internally at the entrance to the glottis.

As to the age incidence, complete fistulæ are a condition mostly of youth. Children are often born with it or it develops during the first year of life. Lateral cysts develop later in life.

The external opening is slit-like. It is often difficult to introduce a probe. The internal opening is small, in the tonsillar fossa behind or just in front of the posterior pillar. Heusinger had a case in which the external opening was big enough to admit a finger tip. The lower end of the canal persists more often than the upper end, as retrogression takes place from above downward.

Complete, internal incomplete, and external incomplete fistulæ are found.

Microscopically, one finds squamous epithelial cells and flat epithelial cells, which go over into ciliated epithelium, which also may consist of

several layers. Similar to the findings in the thymus duct epidermoid findings are due to sinus rests which occur at the angulation area where the thymic duct touches the sinus. If a sinus rest does not break into the lumen of the thymus duct, then a cyst or fistula may develop similar to a dermoid, with hair, coarse material, and other attributes. These deep-seated dermoids are not rare in the neck. Lateral cysts and fistulæ are rich in lymphoid tissue. This shows their close relation to the entoderm and to the thymus. The ectodermal cysts are without lymphoid tissue and come from the sinus rests. The contents of the cysts with ciliated epithelium are mucoid, with squamous epithelium there is an admixture of cast-off epithelial cells.

Thus the clinical and anatomical characteristics, as well as the microscopical structure of lateral cysts and fistulæ, not only are closely related to the embryological anatomical examinations, but also confirm them. We must then recognize that the cysts and fistulæ are closely related to the thymus canal. The structure microscopically is altered by the degree of inflammation.

We should, therefore, give up the name of branchio-genetic cysts and fistulæ, and call them lateral cysts and fistulæ.

*Treatment*—Surgery is the only dependable cure. If a complete or incomplete tract exists, total excision of the tract is necessary (Fig 22).

Two principles of operation have been described by von Hacker and by Fritz Koenig. In these the tract is inverted into the pharynx. This inversion is possible when the tissues are not rigid or fixed. In unfavorable cases in which there is firm fixation near the pharynx, Koenig has described a method in which he dissects the tract as high up towards the digastric as possible and then by blunt finger dissection towards the pharynx. The probe enters the tract from the neck wound and is pushed towards the mucous membrane anterior to the tonsil and at its lower end. An incision is made into the mucous membrane and the probe is pushed through. The wall of the tract is fastened to the fenestrated end of the probe with a ligature or suture, and it is drawn through the opening into the mouth cavity. In other words, it is led through but not turned inside out, as in the favorable cases. The tract is pulled taut and a suture is placed through the opening and through the mucous membrane. The fistula is then cut away, leaving a short stump which curves around the base of the tonsil. The posterior end is in the tonsillar region and the anterior end is at the newly made opening through the mucous membrane. With this method no important structures are injured or compressed (Fig 23).

In cases in which there have been repeated attacks of suppuration with extensive changes and induration, surgical excision is difficult and attended with considerable risk. It should be done only when there is reasonable assurance that it can be completed successfully. Otherwise, conservative treatment should be instituted for the inflammatory condition.

*Complications*—Certain changes can occur in the walls of the cysts either

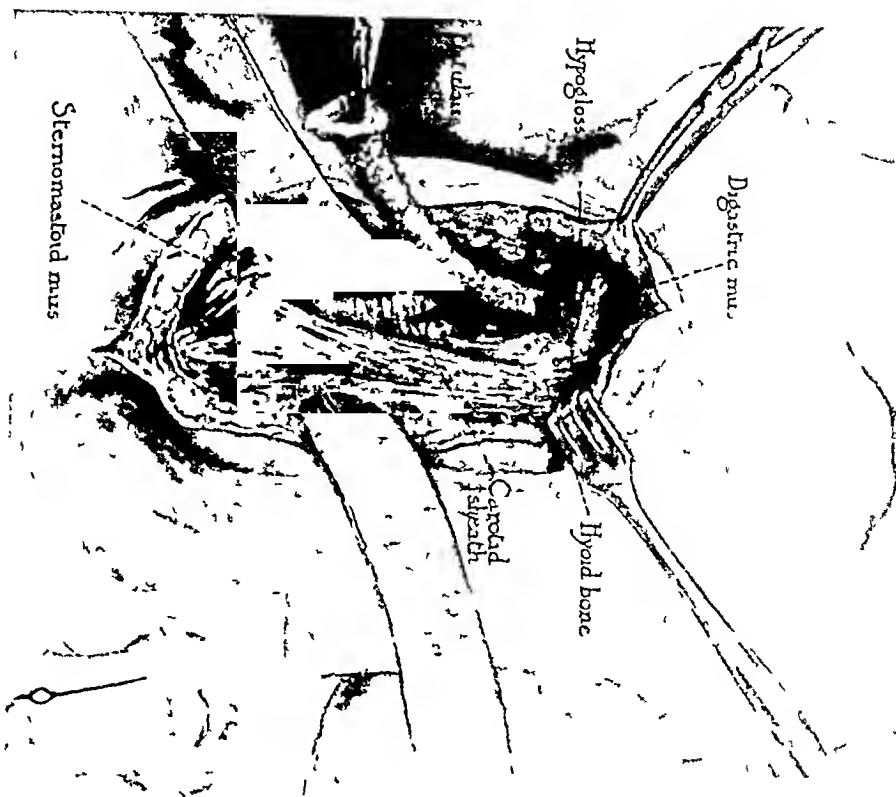


Fig 22

Fig 22—Drawing of lateral fistula of neck, showing course along the median border of the sternomastoid muscle and arch of duct in mid portion of the posterior belly of the digastric muscle toward pharynx (Christophers)  
 Fig 23—Drawing showing method of tracing the inner end of a lateral fistul. 1, 2, 3 show method of von Hacker by inverting the duct with a probe 4 shows Koenig's method of leading duct around the tonsil (Christophers)

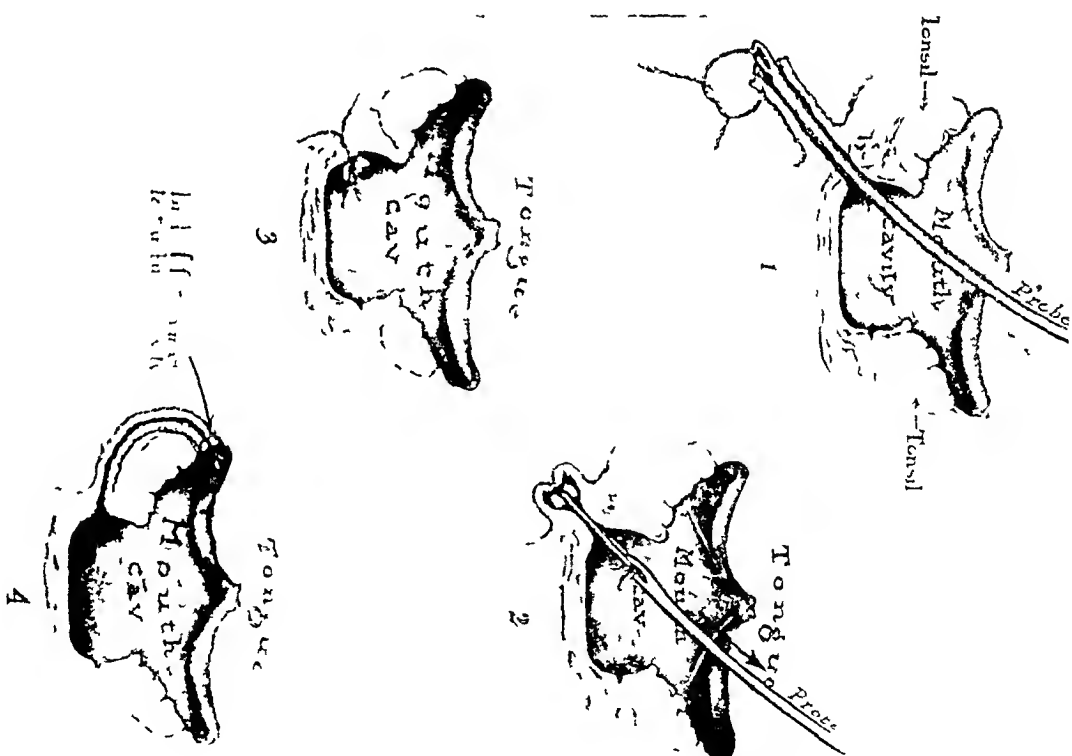


Fig 23

real branchio-genetic in origin or true lateral cysts which may be classified as complications

(1) *Inflammation*—This may form an abscess of the cyst (2) *Blood-vessel Changes*—These may produce blood cysts due to injury (3) *Cyst Adenoma*—This may develop from glandular elements coming from the entoderm (4) *Lymphangioma*—These arise from lymphatic elements in the cyst wall (5) *Chondroma*—This develops from misplaced heterotopic tissue (6) *Teratoma*—There is no explanation to explain the presence of epithelial structures such as bone, teeth, muscle, fat nervous tissue, complete and incomplete small fetuses These often appear in the mouth or the pharynx, notably in the tissues adjacent to the second pharyngeal pouch (7) *Carcinoma*—This has been especially well described in the treatise on surgery of the neck in Nelson's Loose Leaf Surgery, written by Dr George H Semken

Cancers in lateral cysts and fistulae of the neck are rare, but in the epithelial rests of the sinus of the branchial system they are not uncommon

Men have it more frequently than women It develops in adult life, and is of the squamous type of epithelioma Clinically it is carcinoma It is a solitary, hard, fixed mass, with rapid growth and early attachment to the great vessels, displacing the neighboring tissues in expansile growth Later the tumor softens in the centre and eventually breaks through the overlying skin in a fungating mass Regional lymphoid node metastases are a regular finding Distant metastases are rare Pain begins early, due to the close relation to the nerves

Differential diagnosis must lie between lipoma, which has a different texture and consistency, lymphatic hygroma, which has a different location, tuberculous lymph-node, from which it is difficult to differentiate, and metastatic lymph-node carcinoma, which means a careful search for a primary lesion at the root of the tongue, nares, pharynx, hypopharynx, larynx and œsophagus As epithelial inclusions at the base of the tongue are frequent, the primary lesion may be beneath the surface, and a careful inspection and palpation must be made In the lateral region carcinoma of the accessory thyroid or parathyroid glands may occur Branchiogenetic carcinoma has early fixation to the great vessels and is more lateral than the thyroid or parathyroid carcinoma Primary lymph-node tumors and Hodgkins' lymphoid granuloma are softer in consistency and less firmly fixed

The treatment of branchiogenetic carcinoma is careful, complete removal

(To be continued)

# MANAGEMENT OF SKULL FRACTURE INVOLVING THE FRONTAL SINUS

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MUCH has been written concerning the immediate management of frontal sinus fractures. The various complications of the condition have been studied. Dandy (1926)<sup>1</sup> reviews the subject of pneumocephalus and ascribes to fractures of the frontal sinus region an important rôle in the genesis of the condition. Especially if associated with cerebrospinal rhinorrhœa, the possibility of meningeal and cerebral infection and its prevention have been discussed by Peet,<sup>2</sup> Teachenor,<sup>3</sup> Andruss,<sup>4</sup> Naffziger<sup>5</sup> and others. Teachenor, in particular, is very radical in his treatment of fractures of the frontal sinus. He believes in operating on all cases in order to prevent infection. Robb (personal communication) states that in the majority the treatment should be conservative.

In the present paper an analysis of one hundred twenty-five cases of frontal sinus fracture is made, together with a statement of the type of treatment and the results therefrom. This group constitutes a portion of a series of over 2,600 cases of skull fracture seen at the Detroit Receiving Hospital from 1925 to 1929, inclusive. It may be seen, therefore, that fractures involving the frontal sinuses are quite rare, constituting approximately 5 per cent. It is possible that a certain number of this total group may have had fractures in this situation and are not included in this series, because they died within an hour or two after entrance into the hospital, and the sinus fracture probably had nothing to do with their death. Granted the patient's condition permits, he is usually X-rayed within twelve hours after admission. The cases here described have been mostly diagnosed by X-ray. A few had evident compound fracture into the sinus region.

*Discharge from the Nose*—In the present series, there were seventy-one cases with no associated bleeding from the nose. Among fifty-two there were evidences of bleeding which ceased in the course of about a day. In two there was continuous oozing of cerebrospinal fluid and blood, two days in the one case and one day in the other. Of the cerebrospinal group, one died with no evidences of meningitis and the other recovered without any operative procedures being resorted to. Cerebrospinal rhinorrhœa is a serious complication in fractures of the anterior fossa and several investigators deem it advisable to interfere in such instances in order to prevent the infection of the meninges. Campbell,<sup>6</sup> among others, has reviewed several cases of spontaneous and post-operative rhinorrhœa where the incidence of meningitis is quite high, but a certain number of these cases did get well with no operative intervention. In fractures of the frontal sinus, rhinorrhœa is probably more

rare than in case of fracture involving the floor of the anterior fossa of the skull

*Incidence of Brain Injury*—A fracture of the frontal sinus region may be completely free from associated signs of brain involvement. As a matter of fact, the majority of our cases have come in conscious and remained so throughout their stay in the hospital. Nineteen gave no history of unconsciousness following their accident and their recovery was uneventful. Fifty cases showed post-traumatic headaches with a short period of unconsciousness following their injury. Among fifty-one there was a period of unconsciousness ranging from an hour to several hours followed by drowsiness lasting several days. Five had serious brain damage as evidenced by the state of unconsciousness and the neurologic condition of the patient. It is noteworthy, however, to observe in this group that more than one-half the cases had very slight brain damage. Teachenoi (1926) reports eighteen cases of fractures of the frontal sinus region, practically all of which were moribund, with a mortality exceeding 65 per cent. It is true that the series presented in this paper comprise only those who had been X-rayed and had positive evidence of fracture, hence it is possible that a certain number of the cases who entered the hospital in such a serious condition that raying was inadvisable and who died in the course of twenty-four to forty-eight hours may have had fractures involving this region. The number of such cases was very small.

*Location of the Fractures*—Of these one hundred twenty-five cases, the fracture involved the right sinus in fifty-eight instances and the left in forty-nine. There was bilateral involvement among eighteen. There were three cases of compound fracture. A certain number showed definite depression, there were thirteen involving the right sinus, eight, the left, and ten, both sinuses. It is noteworthy to observe that in the majority, the line of fracture extended toward the vertex and hence both the anterior and posterior walls

TABLE I

*Analysis of One Hundred Twenty-five Cases of Frontal Sinus Fracture*

Discharge from nose				Brain injuries				Distribution of fractures				Depressed fractures			Extension of sinus fracture			Operations		Results	
								125 cases				31 cases						3			
None	Epistaxis	Cerebrospinal Rhinorrhea		None	Slight	Definite	Severe								Into vertex	Into base	Outer wall of sinus only	Recovered	Died	Recovered	Died
71	52	2		19	50	51	5	Right	Left	Bilateral	Compound	Right	Left	Bilateral	105	38	11			116	9
																		Recovered	Died	Meminitis	Other causes
								58	49	18	3	13	8	10				3	0		
																				1	8

## FRONTAL SINUS FRACTURES

of the sinus were involved. Very few among them had extensions towards the base of the skull in the anterior fossa, and a few had an involvement of the outer walls of the sinus only. (See Table I.) Three showed definite cloudiness in the sinus, probably indicative of intrasinus bleeding. All three recovered without operative intervention. In this series, there was no evidence of aerocele involving the sinuses. Dandy (1926),<sup>1</sup> in his thorough article on pneumocephalus, states that a great many are caused by fractures in the region of the paranasal sinuses. These are definitely serious and the mortality, according to this author, is around 50 per cent, due usually to meningitis. One of the evidences of aerocele is the presence of emphysema and crepitation on palpation in the neighborhood.

**RESULTS**—Of the total group of one hundred twenty-five, one hundred and sixteen left the hospital recovered. These patients were not followed after their discharge and it is possible that a few of them may have had later complications. During their stay in the hospital, they were free of increase in temperature and all evidences of infection. Nine died. In one, the death was due to chronic alcoholism with pneumonia, the second died of associated brain injury, a third had severe brain injuries and internal injuries, a fourth died of severe brain injury having cerebrospinal fluid leakage from the nose but no evidence of meningitis. Another died of other causes than the brain involvement, namely, fractures of the femur, tibia, fibula, metacarpals, radius, ulna and internal injuries. One died of associated rupture of the bladder, one died of severe injuries in other parts of the body and one died of meningitis. This patient had evidences of bleeding from the nose on entrance. There was no cerebrospinal rhinorrhœa. In these cases emissary veins at the base probably have a great deal to do with the genesis of meningitis. It may be seen that the incidence of meningitis is very low, namely, eight-tenths of 1 per cent.

**Operation**—The three cases of compound fracture involving the sinus region were operated on, a thorough débridement was performed, the sinuses cleaned out and packed with iodoform gauze, this being removed gradually in the course of four or five days. All of these cases recovered. It is our belief that compound fractures in this situation should be taken to the operating room as soon as the patient's condition permits and a very thorough débridement and removal of all foreign bodies performed. The one shortcoming of a thorough operation in this situation is the æsthetic result. With a complete Killian operation, patients are definitely deformed and it may be necessary in due course of time to resort to osteoperiosteal grafts to improve their appearance.

**TREATMENT**—It is our belief that in the majority of the cases, the treatment par excellence is conservative. Operative intervention has many drawbacks. First, such operative intervention is not needed in order to curb the incidence of meningitis, for there are very few among them who develop this disease. Second, the ensuing deformities following a sinus operation leave the patient with a psychic problem which is important to keep in mind.



Third, any operative procedure does shock the patient and might accentuate the signs and symptoms of brain injury. For methodical purposes, the treatment of the various types of fracture in this situation will be taken up.

*Simple Fractures*—Here the treatment is essentially conservative. The patient's temperature and the possible onset of purulent changes in the sinus should be observed. The appearance of emphysema and crepitation in the sinus region and the occurrence of cerebrospinal rhinorrhœa should be watched for. Granted the patient does not show any of these complications, he is left alone and the recovery is usually uneventful.

*Simple Depressed Fractures*—Here again, conservative treatment is advisable unless guided by the clinical condition of the patient, for the majority do well on conservative treatment. To perform radical operations in such cases leads to deformities of the forehead. In case the sinuses are cloudy due to intrasinus bleeding, the patient should be doubly watched for a possible infective process. Three cases of cloudy sinuses in this series recovered with no untoward symptoms.

*Compound Comminuted Fractures*—The treatment in these cases is operative. The patient should be taken care of as soon as his condition permits. The initial cut may be enlarged, a thorough debridement and removal of all foreign bodies accomplished, and, if necessary, a complete Killian operation performed. The posterior wall of the sinus should be inspected for fracture, depressions and foreign bodies. It is advisable in some cases to expose the dura and pack. In this series, the three compound comminuted fractures were operated on with good results.

Rhinorrhœa associated with frontal sinus is uncommon. In this series there are only two cases. Fractures of the base of the anterior fossa are more frequently associated with cerebrospinal leakage. In case the frontal lesion is associated with rhinorrhœa, the treatment according to several authors is operative. Among others, Peet, Andruss and Teachenor profess that they be operated on. Peet, in particular, stresses the placing of a gauze pack over the break in the dura, holding it tightly against the brain. Where possible the tear in the dura should be repaired. Of necessity, such operations are quite shocking and should be performed only if the condition of the patient permits. It should be remembered that a great many of these cases recover spontaneously. In Teachenor's series No. 1, the only patient with rhinorrhœa recovered, whereas the remaining five died of meningitis, brain injury, brain abscess and did not have cerebrospinal leakage. It is essential to get the point of view of the otolaryngologist in this respect. It is known that operations on the paranasal sinuses may be associated with cerebrospinal rhinorrhœa. Campbell, for instance, reports nine cases with five recoveries out of eight. Bromberg<sup>7</sup> reports a case of rhinorrhœa with pneumocephalus secondary to skull fracture who was conservatively treated, being confined to bed for several weeks. This patient recovered. Although the incidence of meningitis in such cases is quite high there are many who

## FRONTAL SINUS FRACTURES

recover By using prophylactic measures, such as abstaining from blowing the nose, leaving the nasal cavities alone and avoiding intra-nasal douches, a great many of these cases recover Cerebrospinal rhinorrhœa may be associated with pneumocephalus This is a serious complication, the mortality in untreated cases, according to Dandy, being around 50 per cent Dandy's suggestion that such cases be operated on by means of a frontal flap and repairing the area of leakage seems to be good surgery However, the necessity for this surgical intervention should be guided by the course of the patient's condition In this series, we have had no case of ariocoele of the frontal sinus Should they occur and are uncomplicated, they should be left alone One complication, according to Robb (personal communication) is emphysema of the surrounding tissues with ensuing cellulitis In such cases, this observer thinks that the frontal sinus should be opened in order to prevent the possibility of septicæmia and meningitis

*Suppurative Sinusitis*—Although no case of suppurative sinusitis following fracture occurred in this series, such a possibility exists and these cases should be watched carefully and very often treated surgically Suppuration in this situation may be followed by extradural or intradural abscesses or brain abscesses The patient should be watched for onset of such complications The face-down position may afford gravity drainage in cases of suppurative sinusitis With such a position, extension of the infection toward the cerebrum may possibly be curbed

In summing it may be stated that the treatment of fractures in the frontal sinus region, with the exception of compound fractures, is essentially conservative Most cases of rhinorrhœa get well spontaneously and even with this complication, we should not find fault with conservative treatment Infection in the frontal sinus should be carefully watched for and surrounding cellulitis and evidences of infection often call for surgical treatment

### SUMMARY

The incidence of frontal sinus fractures in a series of over 2,600 cases of skull fracture is around 5 per cent

The majority of sinus fracture cases are asymptomatic They should be confined to bed for a period of eight to ten days at least They should not be permitted to blow the nose Intranasal douches are counterindicated

The patient should be watched for infection in the sinus and suppuration within the cranial cavity

Compound fractures in this situation should be operated on as soon as the condition of the patient permits The posterior wall of the sinus should be inspected

The great majority of frontal sinus fractures should be left alone The results with conservative treatment are gratifying

The incidence of meningitis in this series is eight-tenths of 1 per cent

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# OSTEOMYELITIS OF THE JAWS IN NURSLINGS AND INFANTS

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IN ANOTHER communication, the general subject of osteomyelitis of the jaws was extensively discussed. The subject was found to be a very complex one, and it was pointed out that cases of osteomyelitis of the jaws occurring in nurslings and infants have, because of their extraordinary manifestations, become separated from the general subject of osteomyelitis of the jaws, and have been considered more or less as a distinct entity. The group has been surrounded with several theories as to the pathogenesis of the disease which have little more to substantiate them than a collection of casual and isolated case reports called from the literature and fortified by the analytical consideration of the given writer. Up to the present time this has necessarily had to be so because the disease being a rather uncommon one, it does not fall to the lot of any individual to observe for himself any considerable number of cases.

The present communication deals with such cases of acute osteomyelitis of the jaws—both upper and lower—which occur most commonly in the first few weeks or months of life, and very rarely beyond that period, and which are characterized (1) by pathological manifestations associated with the osteomyelitis which are referable to the mouth, the nose, the nasopharynx and the orbit, (2) by the clinical manifestations associated with an acute infection of severe intensity, (3) by sequestration and loss of the entire jaw and of the teeth which it customarily carries, (4) by the subsequent deformity associated with this loss in the fortunate cases which recover, and (5) by a high mortality.

Similar clinical entities have been described under various names: gangrenous or sequestering inflammations of the tooth-pulp of early infancy (Bronner), maxillary osteomyelitis of infants (Bronner), gangrenous osteogingivitis (Comby, Cozzolino, Bindl), phlegmonous pulpitis (Bronner), sequestering inflammation of upper jaw (Van Gilse), peri-alveolar abscess (Moser, S. Kakals), ulceromembranous stomatitis (Gilberti), the stomatitis of Vincent, the sequestrierende Zahnkeimentzündung (Zarfl), and empyema of the Antrum of Highmore in infants (Kelly). The affection of such varied terminology is always described as having a local character, but the confusion in which the subject exists is well illustrated by the fact that at times the cases are described as occurring during the course and apparently as a consequence of some general infectious disease, such as measles, whooping cough, *etc*. Such cases, however, are better dissociated from the group occurring in nurslings and young infants, and are better considered as being ordinary cases of hæmatogenous infection of the upper or lower jaw.

*Literature*—An extensive literature has grown up around this subject. The first case of osteomyelitis of the superior maxilla in infants reported in the British literature was by Douglas, in the *British Medical Journal*, in 1898. The first case reported in American literature was by Posey, of Philadelphia, in 1912, in the *Journal of the American Medical Association*.

*Clinical observations* have been made by Moser, S. Kakals (1899), Comby (1904), Kelly (1904), Broca (1904), Movestini (1905), Cozzolino (1906), Gilberti (1907), Scott-Ridell (1909), Landwerhammer (1909), Fless (1912), Rocher (1912), Bindi (1912), Zarfl (1913), J. Francasis (1914), R. Petit (1915), and by Landette (1916). The observation is made by many of these that osteomyelitic and necrotic processes of the jaw-bones are peculiar to the first year of life.

Neumark (1897) tabulated thirty cases of osteomyelitis and finds that the superior maxilla was attacked in three cases and the mandibula in two cases.

Dependorf (1907), from the Surgical Clinic of Jena, reports 600 variously localized cases of osteomyelitis and finds that the process is localized eight times in the mandibula and only twice in the superior maxilla.

In 1922 Marx, in the *British Journal of Ophthalmology*, reviewed the thirty-five cases reported up to that time, paying especial attention to the orbital symptoms. He added three cases of his own. Since that time there have been numerous cases reported both in the American and foreign literature, and it began to be realized that cases of this type are not so rare as it was at one time thought.

Kelly (1924) reported a case of his own to which he added seventeen cases collected from the literature.

Bronner (1925) cites altogether forty cases which he was able to find in the literature, which he regards as maxillary osteomyelitis of infants, but which were recorded under the most varied terms and brings the clinical manifestations into accord with the pathologico-anatomical findings, which he explains.

Bass (1928) reported several cases and reviews the subject from the standpoint of his own cases and from what he gathered from the literature. He added five cases from the literature to those collected by Kelly and quotes a case described by Mayer.

The monograph of Waton and Aimes (1912) contains twenty-three cases of osteomyelitis of the jaws in children between two and thirteen years of age. The report of Cavina-Pratesi (1924) compiled from the Pediatric Clinic in Florence also concerns children from six to eight years of age. These reports had better be excluded from the present discussion.

*Etiology*—As regards the etiology, practically all writers are agreed that osteomyelitis of the jaws just as that of the long bones, must be attributed to bacterial infection. As to the nature of the organisms which cause this disease we know but little. The experience of Allard and Sicard is that in the osteomyelitis of infants and young children pneumococci and streptococci

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play a much greater and commoner rôle than staphylococci, in older children and in patients of more mature age the latter organisms are most common in cases of bone infection. A coliform bacillus, however, is a common finding in this group of cases. My own experience is that staphylococcus aureus is the commonest organism found in osteomyelitis.

The available sources of the infecting organisms are (1) the vaginal canal of the mother, (2) the fingers of the accoucheur or of the nurse, (3) the nipples and breasts of the mother, (4) the fingers or apparatus used in cleansing the baby's mouth after birth.

*Pathogenesis* —The question as to whether this peculiar disease in nurslings is a metastatic lesion similar to other forms of osteomyelitis, or whether it is a primary infection of the jaw and a primary lesion has not received a unanimity of opinion. Only a minority of the observers have taken it for granted that a general infection must preexist and that the jaw infection is secondary thereto.

Galli reports a case in which he believes that the osteomyelitis of the maxillary bones must be regarded as hæmatogenous in origin and not caused by external affections. A septicæmia was caused by the *Bacillus coli* and in its course it implicated the bone and brought about the renal and hepato-biliary complications. In one of Bass's cases staphylococcus aureus was found in the blood which would also favor the mechanism of a hæmatogenous infection.

The majority of observers have believed that this form of osteomyelitis of the jaws in nurslings and infants is a primary lesion. The various discussions have centred themselves about the method of and the point of entry of the organisms into the maxilla and from whence they came.

Most of the observers who report on this subject are of the opinion that the alveolar border is the spot where the bacteria enter. This supposition appears to them to be perfectly feasible, because this area of the mouth offers the best opportunity for the invasion of bacilli through small superficial abrasions. It is obvious to them that the alveolar process must be the most easily wounded spot in the maxilla.

The small wounds in the mucous membrane may originate in a birth trauma, *i e*, pressure produced by a narrow pelvis, or by pressure from the forceps, or by a face delivery where the fingers of the accoucheur must often go into the mouth. Landwehrmann has, moreover, drawn attention to the fact that in cleansing the mouth, small wounds may be inflicted.

According to Bass and others, some have apparently followed infection developing in the mother. According to Marx there is one clear example of infection from the mother's vagina in the literature, and there are cases of infection in nursing infants described by Douglas and Lacasse and by Marx in which a lymphangitis of the breast was present in the nursing mother. Nevertheless, the bacteriological studies in these cases seem to be insufficient. Intrapartum intranasal infection has been mentioned, but this is assumed to be unlikely. In one of Bass's cases the infant was apparently in excellent health, and the labor had been normal. In another of his cases there was a

furuncle on the ankle, and impetigo neonatorum had been present for two weeks. Small skin wounds and ecchymoses were present also in the cases of Wood and Dujardin.

There is a difference of opinion among the various observers who believe in the "primary" nature of this disease as to the part of the jaw—and this applies especially to the upper jaw—in which the infection originates and centres, and from which it spreads. Opinions differ and vary between the nasal cavity, the antrum of Highmore and the unerupted teeth.

Intrapartum intranasal infection has been mentioned. Paunz, of Budapest, claims that all cases are due to an antrum infection, and a minority agree with that position. However, most of the observers agreed that until more detailed investigations of the antrum early in the disease could be done both by X-ray and by puncture with washing, the differentiation cannot be definitely made.

Inflammation of the tooth-buds in the course of a sepsis or an erysipelas in the new-born has been described by Swoboda and by Zwarfl. The last observer made a detailed histological study of such cases and apparently proved to his own satisfaction that a gangrenous process arose in the undeveloped teeth. Finkelstein and von Reuss also believed that osteomyelitis of either of the jaws begins about the tooth buds. The Koerner Clinic, which seems to have investigated these cases closely, hold to the view that it is caused by an infection of the unerupted teeth chiefly the tooth anlagen of the canines and milk molars and with that view the majority of old and new writers on the subject agree.

Proceeding further from these premises the various observers agree that having once settled in the maxilla the bacteria develop further in the spongiosa of the bone. The process increases progressively just as in the osteomyelitis of the long bones, it is followed by suppuration and finally by necrosis and sequestrum formation. Although the clinical picture is sharply defined, its diverse manifestations have caused many of the cases to be described as infections of the antrum of Highmore, others as osteomyelitis of the jaw and others as phlegmons of the orbit. Schmiegelow was the first to show that these cases were in reality cases of osteomyelitis, and Kelly pointed out that the whole superior maxilla is involved, and that evidence of its disease is presented by each of the bony surfaces—the orbital, nasal, facial, and palatal.

My own impression and belief is that osteomyelitis of this type occurring in nurslings and infants is in no way different from the hæmatogenous form of osteomyelitis in general occurring in other parts and bones of the body, and that the occurrence of the lesion in such young subjects is associated with the physical conditions of childbirth and the environmental conditions immediately following. The localization in the jaws is, as is held by almost everybody, due to various forms of minor or major injury received during childbirth or to various forms of trauma received thereafter associated with the care of the child, especially with the cleansing of the mouth. The predilection of the upper jaw is due to its larger size and its more rigid construction.

and attachment in the skull which favor the more frequent reception of traumatism. The presence of unerupted teeth and teeth germs or buds determines areas of more marked vascularity which help to determine points of fixation for the metastatic infection. The traumas described as occurring on the alveolar border or elsewhere, which are taken to be the primary points of entry for the infection, should not be assumed to make pathways directly to the bone, these are points of entry pure and simple and the transmission into the substance of the jaws is only made possible by way of the blood-stream and not by simple extension by contiguity.

The mechanism of the pathogenesis and pathology of hæmatogenous osteomyelitis in general has been discussed very extensively on a number of previous occasions and an extensive discussion of this subject will not be repeated here. Suffice to say in résumé that

Acute hæmatogenous osteomyelitis is a metastatic lesion during the course of a bacteriæmia, the latter resulting from an acute bacterial lesion on a surface of the body which forms the portal of entry for the infection. In this conception a surface of the body includes not only the skin, but also the entire mucous membrane of the alimentary tract, the genito-urinary tract, *etc.* The common surface lesions include not only furuncles, carbuncles, *etc.*, on the skin but also easily demonstrable lesions in the tonsils, and in other lymph-adenoid collections lying in the mucous membrane of the pharynx, as well as less demonstrable lesions, such as those in the Peyer's patches.

The fundamental cause of the spreading of the original lesion in the form of metastatic or subsidiary lesions is an infected thrombus lying in the original area of infection, and communicating at some point with the freely circulating blood. Organisms, growing on the surfaces of the thrombus are discharged, or the pieces of the thrombus itself break off and are discharged into the circulation and, becoming lodged for various reasons in the vascular network of various parts of the body, give rise to secondary lesion. Bone tissue, because of its peculiarities in vascular structure, seems particularly prone to the blocking of these thrombo-emboli and the susceptibility to this is particularly increased during the period of growth when the individual bones contain well-marked hyperæmic areas at the junction of diaphysis and epiphysis, around centres of ossification, *etc.*

The various accessory causes, such as trauma, that determine the localization of a secondary focus of infection—fixation point—in a given bone, are associated with accidents in the local circulation which facilitate blocking of any bacterial thrombus-embolus. The essential nature of the pathological process that develops at the fixation point is a thrombo-arteritis or thrombo-phlebitis, and the process in the jaws is exactly similar to that in other bones in which a dominating position is assumed by the secondary vascular thromboses which must necessarily occur in such a pathological lesion. The all-important secondary effect which these thromboses produce are disturbances of essential nutrition which lead to the death of certain bone cells and the consequent necrosis of certain areas of bone tissue.



The actual pathogenesis and pathology is exactly similar to other cases of hæmatogenous osteomyelitis. The point of fixation in the vascular channels of either of the jaws develops into a thrombo-phlebitis. The occlusion of the vascular channel or channels results in the usual deprivation of blood supply and nourishment, and the amount, degree, and character of the resultant necrosis is in direct proportion to the number, size, or importance of the vascular channel occluded and the amount of available collateral circulation.

The blood supply of the superior maxilla is very abundant and is furnished by a number of moderately large vessels (the infra-orbital (Fig 1), the alveolar, the descending palatine, sphenopalatine, the ethmoidal, the frontal, the nasal, and the external maxillary vessels). Practically all of these vessels are derived from the trunk of the internal maxillary artery. The anastomosis is very free and none of the arteries function as end arteries. The various aspects and areas of the maxilla which are supplied by the various vessels is fairly accurately indicated by their descriptive names. Practically the entire segment of the alveolar process is supplied by the alveolar branch of the internal maxillary artery and its continuation as the posterior dental artery.

A periosteal network is practically non-existent, the little which corresponds to this is derived from an abundant network in the mucous membrane covering the alveolar process of the bone. The physiological proof of this deficiency is found in the total absence of any new bone formation after disease or destruction of any part of the bone.

The vascular arrangement for the inferior maxilla is as follows. The inferior dental artery penetrates the foramen on the inner side of the ramus of the jaw, and runs along the dental canal in the substance of the bone. Opposite the first bicuspid tooth it divides into two branches, incisor and mental, the former is continued forward beneath the incisor teeth as far as the symphysis, where it anastomoses with the artery of the opposite side, the mental branch escapes at the mental foramen, and anastomoses with the submental, inferior labial, and inferior coronary arteries. The dental and incisor arteries during their course through the substance of the bone give off a few twigs which are lost in the cancellous tissue, and a series of branches which correspond in number to the roots of the teeth, these enter the minute apertures at the extremities of the fangs and supply the pulp of the teeth. Collateral circulation is furnished from the opposite artery and by its mental branch with the submental, inferior labial and inferior coronary arteries.

For our purpose this description may be paraphrased as follows. Each inferior dental artery acts as a nutrient artery for its appropriate half of the bone, it perforates the substance of the bone on the inner surface of the ascending ramus of its appropriate side, divides dichotomously and nourishes the bone up to the upper ends of the rami, in fact the two inferior dental arteries are the nutrient arteries of the inferior maxilla. The upper ends of the rami are supplied from adjacent muscular branches.

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The periosteal circulation is derived from numerous arterial trunks—muscular and other—in the immediate neighborhood, it is most abundant over all parts of the bone except the upper part of the ascending ramus and

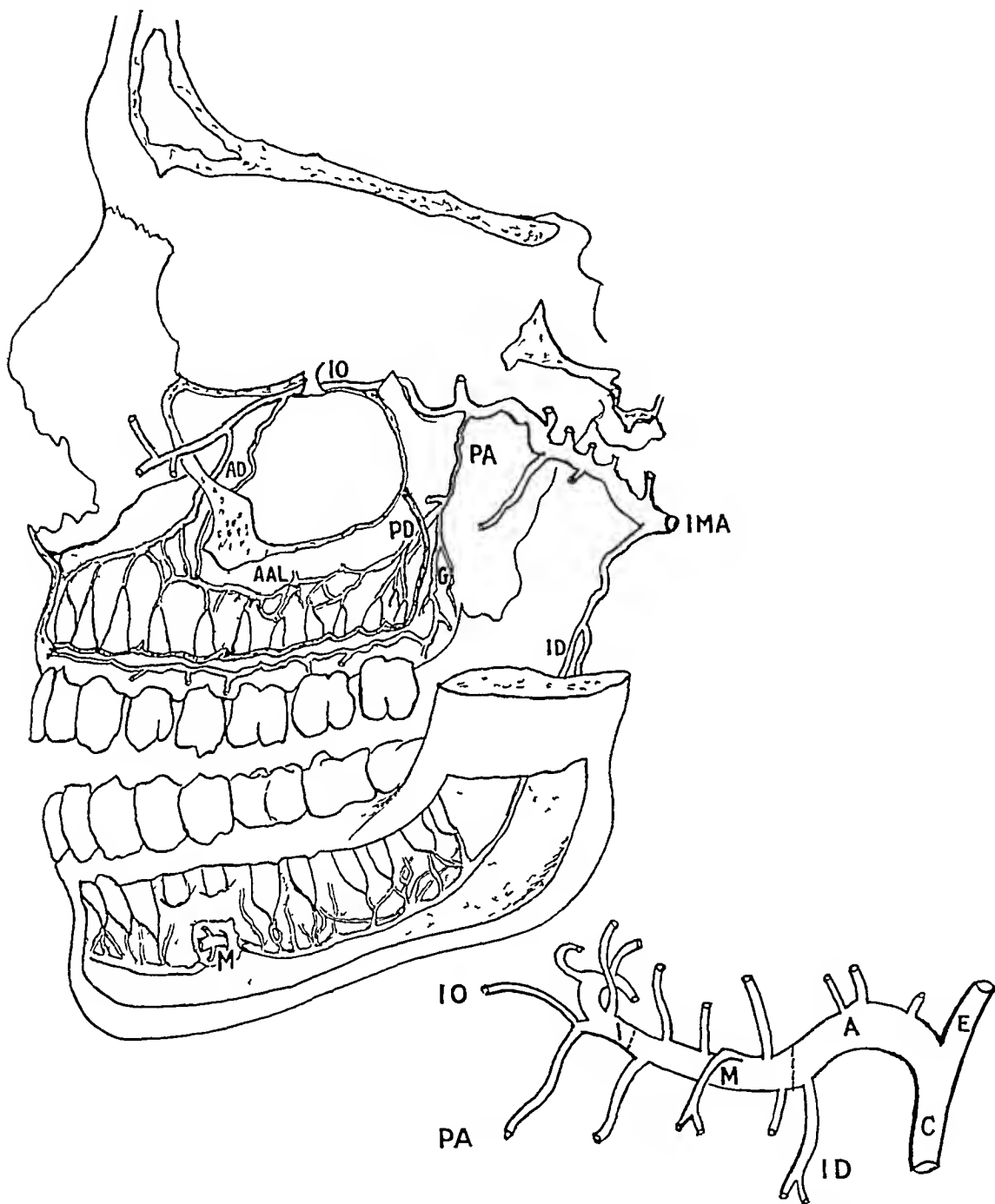


FIG 1—To show the blood supply of the superior and inferior maxillæ. The entire blood supply of the superior maxilla is derived from one large arterial trunk, the internal maxillary artery, and the branches supplying the bone consist of, and are arranged, as a number of loops thrown around the bone at different levels and in different planes. For example, note the loop formed by the infra orbital branch and the posterior dental branch by the interposition of the anterior dental branch of the former, etc. The inferior maxilla is supplied by one loop formed by the two inferior dental arteries each of which is also a branch of the main trunk of the internal maxillary artery. IMA—the internal maxillary artery. PA—the posterior alveolar artery. PD—the posterior dental artery. G—the gingival branch of the posterior dental artery. AD—the anterior dental artery. AAL—the vascular loop from which the apical arteries are derived. IO—the infra orbital artery. ID—the inferior dental artery. M—the mental branch of the inferior dental artery. (After Deaver.)

its coronoid and condyloid processes. Here the periosteal structure disappears in the intimate rugged attachment of muscles, tendons and ligaments.

The interesting part of the blood-vessel arrangement for both the superior and inferior maxillæ is found in the dominating fact that the entire supply is derived from one large arterial trunk, the internal maxillary artery, and that the branches which form the network of supply are arranged in loops based on the trunk of the internal maxillary artery, each superior maxillary bone is fed by a series of loops which are united in a stem based on the trunk of the internal maxillary artery of its appropriate side, the inferior maxilla is fed by a single vascular loop passing from the internal maxillary artery of one side to that of the other. Study of Fig 1 will amply demonstrate this fact, as an example, note the loop formed by the infra-orbital artery and the posterior dental artery by the interposition of the anterior dental branch of the former, or the loops formed by the gingival branch of the posterior dental artery with the nasal branch of the infra-orbital. It is as if a series of loops had their free ends gathered in a single bundle corresponding to the main trunk of the internal maxillary artery.

This simple anatomical fact explains very adequately all the clinical forms of osteomyelitis of the jaws which occur in this group of cases as follows

(1) Involvement of the entire bone with manifestations referable to the palatal, nasal, and orbital surfaces results from a lesion in the stem of the internal maxillary artery prior to the giving off of the posterior alveolar branch with or without extension thrombosis in the loops described above which are derived from the internal maxillary artery. Collateral circulation is at a minimum and a maximum lesion results.

(2) Involvement of the alveolar process results from a lesion in the course of the posterior dental and gingival arteries. The amount of bone involved depends on the amount of collateral circulation.

(3) Involvement of the anterior part of the alveolar process and the adjacent part of the bone results from a lesion in the course of the junction of the posterior and anterior dental arteries.

Involvement of the antrum of Highmore occurs with either Group 2 or 3. The amount of bone involvement depends on the possibilities of collateral circulation.

(4) Involvement of the palatal surface results from a lesion in the palatal arteries or may be an extension from an involvement of the alveolar process.

(5) Involvement of the nasal aspects of the bone results from a lesion in the nasal and anterior branches of the infra-orbital artery. This variety may also be associated with an empyema of the antrum of Highmore.

(6) Involvement of the orbital aspect of the bone results from a lesion in the course of the infra-orbital artery.

The controversy as to whether this form of osteomyelitis of the jaw centres in and is derived from a lesion in the teeth buds, the nose, or the antrum, or in the neighborhood of the orbit is to my mind unnecessary and fruitless, inasmuch as from the facts outlined, one can easily see that all of these manifestations are simply determined by the dominating position of the thrombo-phlebitis in the course of the vascular channels described. The

seeming importance of any one manifestation is only a superficial one and the character of the pathogenesis and pathology is, as in other forms of acute osteomyelitis, intimately related with the position of the thrombo-phlebitis and the resultant necrosis

*General clinical course*—In 82.5 per cent of the cases reported in the literature the first two months of life were involved, the greatest number of the cases falling within the second and third week. With few exceptions, the superior maxilla was most frequently diseased. The right and left side were about equally involved.

The disease presents a clear-cut definite picture, one case report being very much similar to the other. The disease usually befalls healthy infants between two and ten weeks of age, sometimes older ones. Prodromal periods differ, sometimes the children cry and refuse nourishment, and there may or may not be a slight rise in temperature accompanied or not by diarrhoea or constipation, in other cases the children are violently ill, with high temperatures, vomiting, and convulsions.

Then the swelling appears. It may begin in the cheek or in the infra-orbital region, and is almost always accompanied by œdema of the lower eyelid. Sometimes there is exophthalmus from œdema of the orbit. The sclera is inflamed, conjunctivitis is present, and there is sometimes chemosis. It is these symptoms which usually bring the patient to the ophthalmologist, for instance, three out of four of Nord's patients came from the ophthalmologist. In the majority of the cases, a localization forms below the inner canthus of the eye. At this site a swelling in the cheek appears, with redness, abscess formation, the breaking through of pus, and the formation of a fistula. In the mouth can be noticed swelling of the alveolar process and of the hard palate. This may appear even before the swelling beneath the orbit, and is likewise followed by perforation, the discharge of pus, and fistula formation. Numerous small sequestra discharge through the sinuses. Another common and characteristic symptom is the discharge of premature teeth through the alveolar sinuses. In nearly all cases there is sooner or later a discharge of pus from the nose, which is increased by pressure on the abscess. All of this occurs within a few days.

The majority of the children are really sick, but a few remain surprisingly well in spite of the progress of the disease. The temperature is irregular, convulsions frequently are present, and there is marked anorexia and difficulty in nursing, due to the pus in the nostril. The outcome is either healing with or without the persistence of discharging sinuses or the development of secondary purulent foci. Contrary to what one might expect, the prognosis is not always unfavorable. In the fatal cases the infants die as a result of the virulence of the infection before secondary foci have time to develop.

The local manifestations correspond to that of a sequestra-containing abscess of larger or smaller extent. These accumulations of pus correspond in their pathology to subperiosteal abscesses (such as occur in other locations

especially in the long bones) in relation to the appropriate surface of the maxilla. In the upper jaw the abscesses develop as follows:

Usually as a final stage a single large abscess cavity exists which harbors the entire, or the major portion, of the necrotic upper jaw, pus is present on all sides in relation to the palatal, alveolar, nasal, orbital, and retro-maxillary aspects of the jaw. In exceptional instances, owing to the position of the thrombo-phlebitic lesion and to an extraordinary amount of collateral circulation, the process seems limited to only one aspect of the bone, then it either accumulates in relation to the upper aspect of the jaw, in which case the manifestations are mainly orbital, or the process seems more limited to the lower aspects of the jaw and the manifestations appear mostly in the mouth or nose. Frequently the primary accumulation of the pus is in the antrum of Highmore, the abscess then usually points primarily in the nose and secondarily in the alveolar process.

In the average case when a probe is passed into one of the discharging sinuses, it passes at once into a large cavity. This may or may not be a much enlarged antrum cavity, it may be one of the enlarged dental sacs, or it may be a large irregular cavity in which practically the entire superior maxilla is housed as a sequestrum.

*Mouth symptoms*—Eighty per cent of the fistulæ in the mouth are found at the alveolar arch of which more than 50 per cent are in the region of the canine tooth. In 60 per cent of the cases an expulsion of the dental pulp occurs. The discharge of teeth and tooth buds through the fistulous openings in the alveolar process, is the most characteristic phenomenon of this disease. It leaves the child without teeth over the affected area. The final result, when the child lives, is a considerable deformity of the face and palate with loss of teeth, both temporary and permanent, on the side involved.

*Nasal and aurial symptoms*—A purulent discharge from the nares is a very common symptom and a fistula is present in the nose which leads to bared or necrotic bone.

As to the pathogenetical side of the question, Van Gilse says that there has always been an infection of the nose in the cases that he has seen. Kummel, on the other hand, says he has never seen infection of the nose. The nature of the anatomical relationships makes it easily possible for one man to see a whole series of cases with rhinogenous manifestations of an osteomyelitis of the upper jaw and for another to see a series with predominating manifestations of another kind. Sometimes a history of rhinitis is not reported but examination shows pus in the middle meatus. Sometimes it is not possible to detect a preceding rhinitis even when there has been one. In Van Gilse's cases the maxillary sinus was definitely found diseased.

Certainly in an advanced case, and, commonly, in early stages of the disease, manifestations referable to the mouth, the nose, and the antrum of Highmore appear as a single entity. Among the various observers, discussion is frequent as to the relative merit or importance of one, over any, of the other of these localizations. For instance, some observers have held that

large suppurated dental follicles have been mistaken for the small maxillary sinus and a great deal is made of an apparently valid objection that such propagation from the maxillary sinus has never been demonstrated histologically. It is pointed out that in order to accomplish this it would be necessary either to examine cases in which the process is not very far advanced or ones in which the mucous membrane of the maxillary sinus is not involved though the disease of the maxilla is far advanced. However, from the discussion in this paper, it should be obvious to everyone that this differentiation is useless and of no importance either in the understanding of the disease as a whole, or of its individual manifestations.

*Eye symptoms*—Of the thirty-five cases tabulated by Marx, thirty developed eye symptoms, and Marx is not certain that the remaining five did not have them. In eight of the records, the eye symptoms first attracted the attention of the patient's family or of the doctor. This is no small percentage, and the eye symptoms are important because it may happen that the ophthalmologist is the first to be consulted, and the further progress of events may depend on his being able to arrive at a correct diagnosis without unreasonable loss of time. This is not always the case and examples of this kind are to be found in one of Marx's cases and in a case of Dujardin.

The eye symptoms which appear in osteomyelitis of the superior maxilla can, for simplicity's sake, be divided into those of the eyelids, of the conjunctiva, and of the eye socket. The symptoms in the eyelids according to Brown Kelly, are those which first attract attention to the process. The swelling, owing to the severe inflammation of the bone, is a severe collateral œdema, and is quite easy to understand.

The swelling and redness in the region of the lacrymal sac and the subsequent fistula are frequent symptoms. They are important because they may also easily lead to an incorrect diagnosis. According to Brown Kelly an abscess often forms in the lower eyelid, and that pus exudes from the lacrymal sac. François expresses himself more cautiously when writing that the discharge from the fistula in the inner corner of the eye causes one to think of a dacryocystitis, but that the accompanying symptoms at once lead the diagnosis in another direction. The fistula is to be explained by the fact that the inflammation often prematurely develops in the nasal process of the superior maxilla and the pus collects there, eventually seeking the easiest method of exit, which in this case leads to the inner corner of the eye. The canaliculi remains untouched, and it is well to remember this, because one might be too zealous, and, to the patient's detriment, begin an active treatment of the canaliculi if one did not pay proper attention to the other symptoms. Marx advises one to be as conservative as possible and even in the commencement of abscess formation in the lower eyelid to make no incision in the abscess, as frequently treatment via the palate and processus alveolaris will effect a complete cure, whilst an ugly drawn scar with ectropion may result from incision, as appears from the report of Avellis.

The conjunctivitis, like the swelling of the eyelids, is usually part of a

collateral œdema The degree of severity of the original infection can thereby appear to a certain extent from the chemosis

Exophthalmus was observed by Marx in ten of the thirty-five cases In comparison with the other eye symptoms, this appears too seldom to be regarded as an expected phenomenon Exophthalmus is also an accompaniment of inflammation of the ethmoid Stephenson has reported ten cases of inflammation of the ethmoid, which all showed exophthalmus to a greater or lesser degree Thus it appears that the protrusion of the eye is attendant on the inflammation of the bony walls of the orbit fossæ which is followed by purulent exudation in the eye socket

It is surprising that in the ophthalmic literature, practically nothing is to be found about the ocular complication of osteomyelitis of the upper jaw There is one reference by Eversbuch (*Die Augenerkrankungen im Kindesalter*), in which he points out the possibility of mistaking a fistulous osteomyelitis of the superior maxilla for a discharging lachrymal duct

*Differential diagnosis*—A differential diagnosis must be made from the following conditions

(1) *Ophthalmia neonatorum*—Usually both eyes are affected, and gonococci can usually be found Furthermore, the œdema does not extend to the infra-orbital region, nor to the alveolar process (2) Erysipelas (3) Dacryocystitis (4) Syphilis (5) Tuberculosis

Careful examination of the patient together with the requisite laboratory work in association with a carefully taken history should result in a correct diagnosis In addition, the characteristic phenomenon of exfoliation of teeth or tooth buds should by itself suffice to call one's attention to the correct condition

*Blood cultures*—One of Bass's cases had staphylococcus aureus in the blood The literature otherwise does not contain any specific statements in regard to this aspect of the disease I feel sure, however, that cultivations of the blood behave no differently in osteomyelitis of the jaws than they do in osteomyelitis of other bones and to this statement Bass's case is a confirmation

*Treatment*—The general principles governing the treatment of acute osteomyelitis in general have been fully described on several previous occasions and will not be repeated here Suffice to say here that in nurslings and infants osteomyelitis of the jaws should be divided for purposes of treatment into the following two groups

(1) This group consists of the cases which terminate fatally as a result of the profound toxæmia which develops The fatalities usually occur in early stages of the disease and whatever one does in the way of treatment is mostly of a temporizing and palliative nature and shows no influence at all on the progression of the local and general phenomena of the disease

(2) This group contains the remainder of the cases It is most important to be as conservative as possible In the early stages, careful cleansing of the mouth, possible poulticing in appropriate cases, and conservative attention to

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the nasal and orbital manifestations are all that is required. As soon as definite areas of fluctuation are discovered, these should be adequately but conservatively incised with due attention to the placing of the incisions. As much as possible should be done from the interior of the mouth and through the nasal cavities. It is surprising how one can reach foci of suppuration at apparently distant points from the buccal cavity especially in the interval between the cheek and the bone, especially in the canine fossa this is possibly due to the general involvement of the entire bone in the process. Marx has been able to adequately drain orbital abscesses from appropriately placed incisions in the mouth. There is no record available of any permanent effect upon the eye itself or upon sight.

Sequestration being common, one should assist nature as well as one can in enabling these necrotic fragments to be discharged. The teeth usually are discharged from the fistulæ in the alveolar process, the major portion of the bone itself usually comes away through an opening in the fold between cheek and bone.

Abscesses in association with the lower jaw are more simple technically, and one should follow ordinary surgical principles in treating them. Sequestra should not be removed until involucrum formation is abundant.

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# RONTGEN VISUALIZATION OF THE PAROTID GLAND BY MEANS OF LIPIODOL INJECTION

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A REVIEW of the literature on the salivary glands shows a paucity of material other than that relating to the subjects of calculus, parotitis, and tumors. The reasons for this are not only the infrequency of other conditions, but also the great difficulty attendant upon the study of changes taking place in the structure of the glands. This difficulty has prompted us to seek a method for visualizing them.

In studying the pathological changes which take place in the gland, the X-ray examination contributes a considerable amount of information not obtained by any other method. Clinical examination, aside from its value in giving information as to size, consistency and mobility, is unsatisfactory and incomplete. Rontgenological examination until recently has been useful only in the study of calculi. Our studies prove the value of the X-ray in demonstrating actual pathological changes in the gland structure.

The technic of injection is simple and, when properly done, is free from injurious after-effects. A blunt, flexible, thin silver canula, a 5-cubic-centimetric syringe, and a fine, flexible probe with a blunt end are all the instruments necessary.

The lipiodol is first warmed so that it will flow easily. In injecting the parotid duct, the patient is seated with the mouth open and the operator uses the thumb of his left hand to retract the cheek. The first and second fingers then press the cheek inward in the region of the papilla. A colored solution of some kind, such as 3.5 per cent iodine, is applied to the papilla, and the opening of the duct is disclosed. With the operator maintaining his position, the flexible probe is inserted and passed into the duct for a short distance in order to verify its patency. In doing this, extreme care must be taken lest the duct be perforated. The probe is then withdrawn, and the flexible canula inserted in its place and from 1 to  $2\frac{1}{2}$  cubic centimetres of the warmed lipiodol injected slowly. There will be some external swelling in the parotid region and some slight discomfort. When pain is felt, the injection is discontinued.

The exposures should be made immediately. A 23-degree reverse angle board is used and the position is the same as that for a temporo-mandibular joint or the ascending ramus of the mandible.

In the presence of any active infection, it is not advisable to inject lipiodol on account of the danger of spreading the infection.

In order to intelligently interpret the films, a complete understanding of

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the anatomical structure and the pathology of the glands is required. The salivary glands are of the compound racemose type, consisting of many lobes which are made up of smaller lobules, bound together by dense areolar tissue, vessels, and ducts. The individual lobules consist of the ramifications of a single duct, whose branches end in dilated alveoli on which the capillaries are distributed. A basement membrane encloses each alveolus, being continuous with the membrana propria of the duct, and consisting of a network of branched and flattened nucleated cells. Grossly, the parotid gland, which is the largest and most important of the salivary glands, is situated on the side of the face, lying immediately below and in front of the external ear. The gland is superficial, irregularly quadrilateral in form, and is bounded roughly by the mastoid process and sterno-cleido-mastoid muscle posteriorly, and the ramus of the mandible anteriorly. The deep surface of the gland extends inward almost to the pharyngeal wall. A small portion lying immediately below the zygomatic arch is usually detached from the main gland. This is the accessory lobe.

The ducts of the parotid gland begin within the lobules, and are known as intralobular ducts. Uniting, these run between the lobules and are then known as minor or interlobular ducts. Uniting still further and becoming larger in calibre, as major or interlobar ducts they run between the lobes, and forming numerous branches from the anterior part of the gland, these finally unite to form Stenson's duct, which crosses the masseter muscle at which point it receives the duct of the accessory lobe. At the anterior border of the masseter muscle Stenson's duct turns inward almost at a right angle, and piercing the fat and buccinator muscle, opens on the oral surface of the cheek opposite the second molar tooth. The relation of the parotid gland to the bony structures is shown in the accompanying sketch (Fig 1).

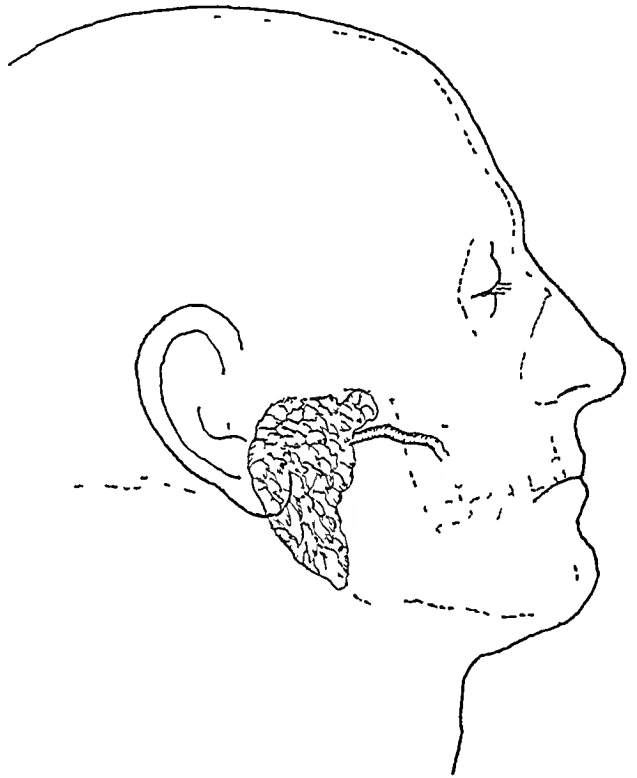


FIG 1—Anatomical sketch showing position of the parotid gland

Since it is evident that changes in the gland will manifest themselves by changes in the appearance of the ducts, it will be convenient to refer to the picture of the normal duct markings as possessing a tree-like or arborescent quality.

Fig 2 shows the normal parotid gland of an adult male. The stream of lipiodol flows along Stenson's duct for a distance of about one-half inch, at which point it is

seen to divide into two branches, one branch going to the accessory lobe, the other continuing to the main gland. As the duct approaches the gland substance it divides into smaller ducts, these major branches extend into the gland between the lobes and divide still further into minor branches which pass between the lobules, and finally into the

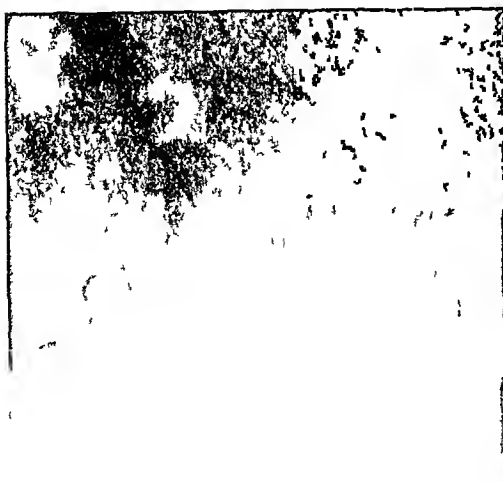


FIG 2



FIG 3

FIG 2—Normal parotid gland. Male, aged fifty years.

FIG 3—Parotid gland two months after clearing up of pyogenic infection and removal of calculus. Male, aged fifty years.

intralobular ducts. The arborescent quality possessed by the normal glands is striking, and gives one the impression of a healthy tree without leaves.

The ordinary conception of Stenson's duct, as a simple tubular structure of even calibre, leading from the gland to the mouth, is incorrect. The duct



FIG 4



FIG 5

FIG 4—Parotid tumor of twenty years' duration. Operated upon eighteen years ago. Re-operated upon after this X-ray was taken. Microscopical diagnosis—Endothelioma. Female, aged fifty-two years.

FIG 5—Parotid tumor after course of X-ray treatment. Male, aged forty years.

not only varies irregularly in calibre, but is somewhat corkscrew in effect. This serves to explain how the secretion may be stopped by a calculus acting

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as a ball valve, the rarity of foreign bodies passing along the duct for any distance, and the difficulty in probing the duct. One must also not overlook the fact that the movements of the cheek affect the duct, straightening its course or making it more irregular.

Fig 3 shows the parotid gland of a fifty-year-old male, two months after disappearance of a pyogenic infection and removal of a calculus, the history being of eight years' duration. After meatotomy of the duct and removal of the stone, the pyogenic infection cleared up, but only after considerable discharge of pus which indicated a wide destruction of the glandular substance. The back pressure and infection in these cases cause a marked destruction of the acini. This picture was made to determine the condition of the gland two months after the infection had completely disappeared.

Although Stenson's duct is normal in length it is markedly dilated. No accessory lobe is present. Major ducts are present but diminished in number. There are some minor ducts but no intralobular ducts can be seen,

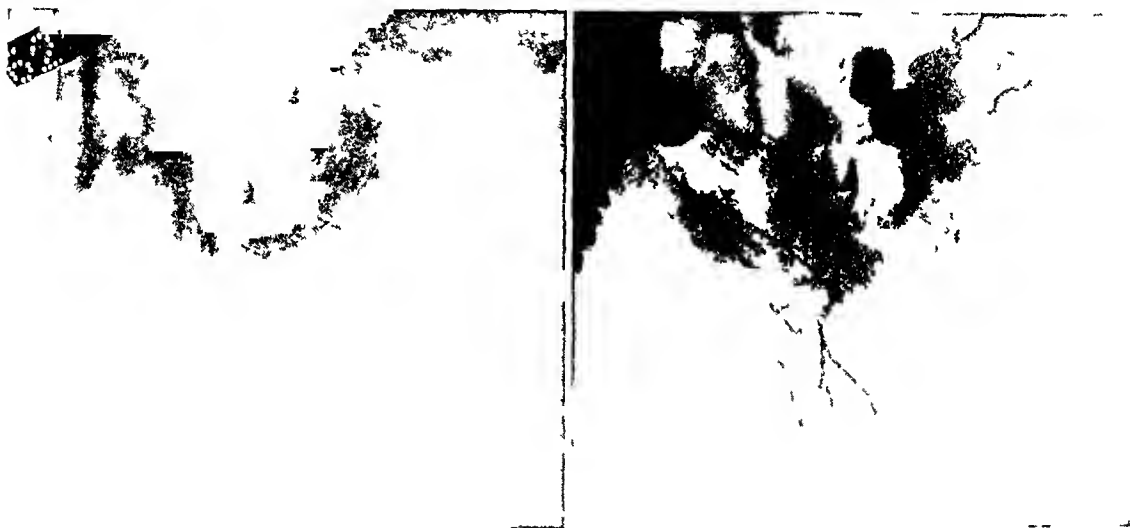


FIG 6

FIG 7

FIG 6—Parotid tumor involving only the accessory lobe of the gland. Male, aged twenty four years.

FIG 7—Parotid tumor. Duration eight months. Male, aged thirty nine years.

indicating marked destruction of the secreting portion of the gland. The true arborescent quality is absent, and the appearance suggests a picture of a dead tree.

Fig 4—This was a female, aged fifty-two, who gave a history of an operation on the right parotid gland eighteen years ago. At the time of our examination, there was palpable in the region of the gland a firm, rounded, movable tumor about the size of a walnut. There was no pain.

Lipiodol injection shows Stenson's duct to be markedly constricted. It is looped near its orifice like the script letter "e". There are no duct markings as are seen in the normal parotid, but there appears to be a great deal of dense fibrous tissue. The arborescent quality is entirely absent.

The tumor was removed surgically and a pathological diagnosis of endothelioma made.

Fig 5—This patient was a male, aged forty, with a parotid tumor that had been treated by X-ray. This picture was taken several months after completion of the course of treatment. Stenson's duct is of normal calibre, but somewhat lengthened, this lengthening may be only apparent due to destruction of major ducts, which are diminished in

number and calibre. Few minor ducts are present and the absence of intralobular ducts points to destruction of the secreting portion of the gland. The arborescent quality is considerably diminished.

Fig 6—This was a male, twenty-four years of age, who had a parotid tumor involving only the accessory lobe of the gland. The condition was of one year's duration. Lipiodol injection shows Stenson's duct to be of narrowed calibre and undulating course. The duct of the accessory lobe joins Stenson's duct about one-half inch from the orifice. The duct markings of the main portion of the gland are normal, possessing the arborescent quality. The absence of the duct markings of the accessory lobe indicate a diagnosis of tumor involving only this lobe.

Fig 7—This was a male, thirty-nine years of age, who for the past eight months had a mass below and in front of the ear in the region of the angle of the jaw. During the last three months the mass increased in size rather rapidly and there was a moderate amount of pain.

Throughout the entire picture the fine intralobular duct markings are not present. This absence of the true arborescent quality is not due to a deficiency of injection. The

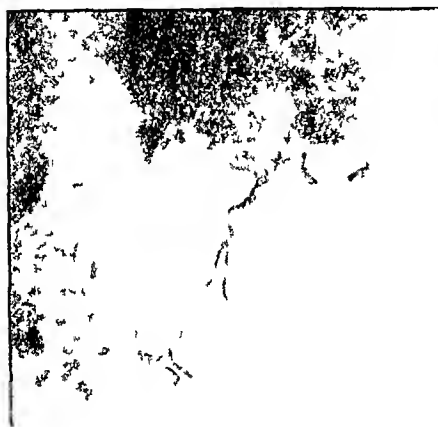


FIG 8

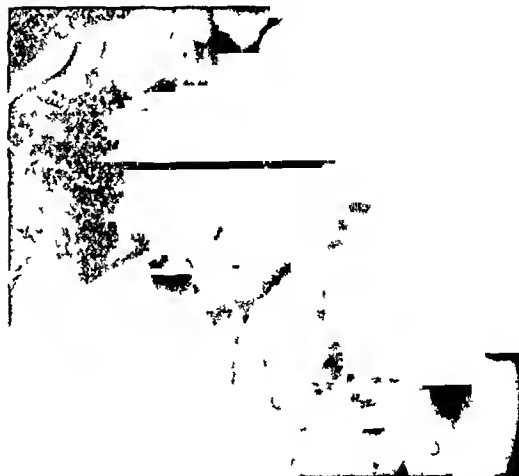


FIG 9

FIG 8—Parotid tumor. Duration six years. Male, aged forty-eight years.

FIG 9—Parotid fistula of twenty-three years' duration. Patient, aged twenty-seven. X-ray with lipiodol injection and stylet inserted into fistulous opening on free. At the age of four years this patient had a swelling on the right side of the face operated upon. Unable to determine the precise nature of the condition for which the operation was performed.

poor definition of the duct markings is noted particularly in the region of the angle of the jaw. We feel that this parotid tumor, on account of its rapid growth, the presence of pain, and the widespread absence of fine duct markings, possesses a malignant character.

Fig 8. This patient was a male, forty-eight years of age, who had a soft mass in the cheek for six years, the growth was very slow and the patient was practically free from pain during the entire period.

Lipiodol examination shows the retro-angular portion of the gland to be normal, but from this part of the gland up to the point where the ducts unite to form Stenson's duct, the markings are indistinct, and those that do appear are constricted. This area corresponds accurately to the region of the tumor of the cheek, absence of pain and localization of destruction of gland substance is probably a more benign condition.

Fig 9—This was a female, twenty-seven years of age, who gave a history of an operation on a swelling on the right side of the face at the age of four years, the precise nature of the condition or operation we were unable to determine. At the time of our examination (twenty-three years after operation) there was present a fistulous open-

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ing, pinpoint in size, on the right side of the face about one and a half inches anterior to the external auditory meatus, a fine stylet could be passed into the fistulous tract

The rontgenogram taken with stylet in place following injection of lipiodol into Stenson's duct shows the fistulous tract opening directly into Stenson's duct near its formation, at this point there is a small triangular cavity filled with lipiodol. In a case of this type examination by lipiodol injection is important as the treatment of a fistula of the duct differs from that of a fistula of the gland proper

Fig 10—This was a female, aged forty-nine, who gave a history of one year's duration of a tumor in the region of the left parotid gland, which had been gradually increasing in size and was accompanied by pain, an operation was performed before an X-ray was taken, and a small encapsulated tumor removed from the body of the parotid gland. Pathological diagnosis of basal-cell epithelioma was made and the patient received a course of X-ray therapy. Three weeks after the last treatment she was referred to us for examination by lipiodol injection

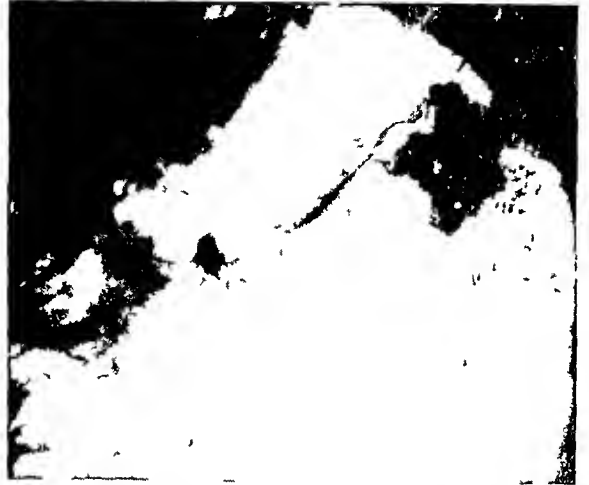


FIG 10—Parotid tumor post operative. Rontgenogram taken three weeks after the removal of a small tumor from the body of the gland

The rontgenogram shows Stenson's duct to be normal in appearance, near its formation there is an irregularly oval cavity filled with lipiodol, which is probably the area from which the tumor was excised, the arborescent quality is considerably diminished throughout the gland as a result of the radiation therapy. Re-examination with lipiodol injection four weeks later showed the condition unchanged

### CONCLUSIONS

(1) Rontgen examination of the parotid gland after lipiodol injection is a simple, safe procedure when properly performed. In our series no injurious effects have resulted from the injection

(2) Injection of the gland with lipiodol should never be made in the presence of active infection

(3) At present, this method is the only accurate way of determining the exact condition of the gland and its deviations from the normal when diseased. In cases of parotid fistula, actual visualization of the ducts is of the greatest aid in determining the course of treatment

# PRIMARY TUBERCULOSIS OF THE PAROTID GLAND

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FROM THE CUMBERLAND HOSPITAL UNDER THE AUSPICES OF THE MOUNTAINSIDE HOSPITAL RESEARCH FUND

TUBERCULOSIS of the parotid gland, according to medical literature, is rare. We therefore feel justified in reporting the following case.

A D., aged forty-eight, presented herself October 5, 1930, with a swelling of the right parotid gland which had come on gradually during the previous ten months. There had been no pain until two months previous when she began to experience neuralgic pains along the right zygomatic region. The mass was firm in consistency, the skin was glazed, reddish and tense, but not attached to the mass. The tumefaction extended upwards to the zygoma, downwards over the ramus of the mandible and the angle of the jaw anteriorly to the angle of the mouth. A thorough physical examination was negative. Wassermann and other tests were also negative. There were no cervical glands palpable. The pre-operative diagnosis rested between mixed tumor of the parotid, sarcoma, and tuberculosis, the first seeming the most likely because of the slow growth and duration. Tuberculosis was not considered because of its rarity.

October 20 operation for removal was done. By an incision starting at the angle of the jaw and running along the ramus of the mandible, and another from the angle upwards to the zygoma, the tumor was exposed. All was removed except a small portion that was closely adherent to the main trunk of the facial nerve. The post-operative career was uneventful except for a salivary fistula that formed at the lower incision which cleared up at the end of two weeks. The patient was then given two X-ray treatments and has now made a complete recovery.

The pathological report submitted was as follows. These sections show a predominance of epithelioid tubercles throughout, with central areas of organization and giant cells of the Langerhans type with an outer zone of fibrous connective tissue and round cells. This is a rare condition of the parotid gland. It is advisable that a thorough examination be made for the primary focus of tuberculosis in this case.

*Diagnosis*—Tuberculosis of the parotid gland.

*Review of Literature*—The parotid gland may be infected with tubercle bacilli either through Steno's duct by way of the lymph-channels or through the blood-vessels.

In October, 1914, Thomas F. Carmody gave a review in the *Laryngoscope*. He reviewed the cases of tuberculosis of the parotid gland, of which, at that time, there were four in this country and eleven abroad. He mentioned such cases as de Paoli's case, which was a male aged thirty-three, without a previous personal or hereditary history of tuberculosis, who presented himself with a swelling of the left parotid about the size of a hen's egg, a size attained in six months' time. He further presented a facial paralysis on the affected side. Under diagnosis of sarcoma the tumor was removed. Examination revealed tuberculosis. This author ventured no opinion as to the origin of the tumefaction.

In 1894, von Stubenrauch reported a case which presented some different characteristics. A male, aged sixty, who had suffered from stomatitis and accompanying salivation, presented a small fluctuating mass in the right parotid region, which was very painful. *Pathological examination*—A large pseudo-cyst with liquid contents similar to saliva, and with a wall about two centimetres thick internally showed tubercular granulations, while externally there was a capsule consisting of fibrous connective tissue, with

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the remains of excretory ducts, led von Stubenrauch to believe that infection took place through Steno's duct

In 1895, another case was reported by de Paoli. The patient was a girl of nineteen, whose left parotid was involved, and in spite of his previous experience, he made a diagnosis of fibro-sarcoma. Pathological examination after removal proved it to be tuberculosis. In the same year Legueu and Marien reported a case of a girl of thirteen years, in whom there had formed during a long period a swelling as large as a nut, covered with skin, and apparently adherent to the left parotid gland. A diagnosis of adenitis was made, but examination disclosed many tubercles diffused in the parenchyma of the gland, and a central softened mass. The case of Bockhorn, reported in 1897, was that of a lady, thirty-nine years old, with no previous history of tuberculosis. There was to be seen a swelling of soft consistency, which had formed in the left parotid region in the previous three months. Pathologically it was recognized as tuberculosis of prob-

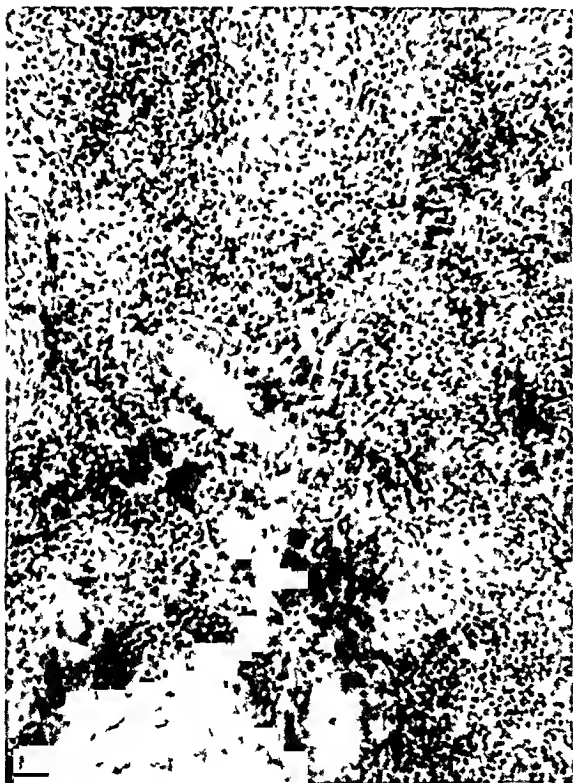


FIG 1

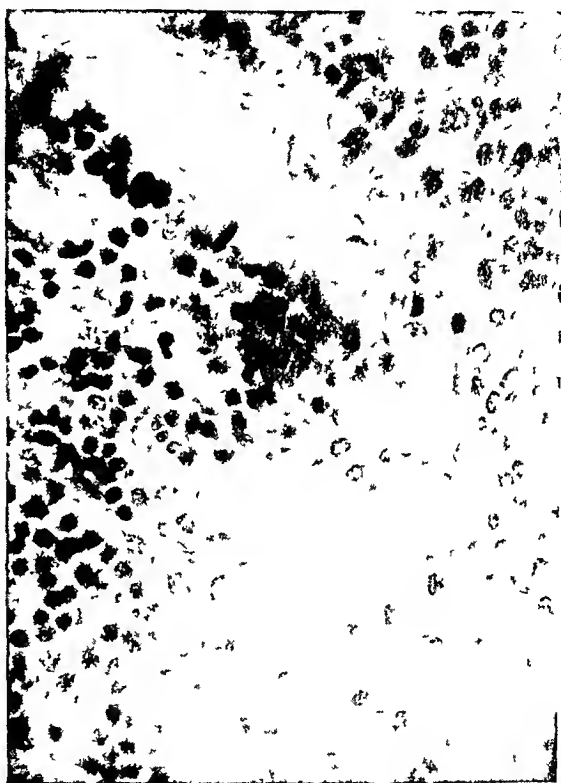


FIG 2

able vascular origin, on account of the great abundance of tubercles in the region of the vessels. The pre-operative diagnosis was a syphilitic gumma.

In 1897, Kiesow published at *Griefswald* "Ueber einen Fall von Isolirter symmetrischer Tuberkulose der Parotis" (Case of Isolated Symmetrical Tuberculosis of the Parotid Gland). A girl of thirteen had for three years presented swelling in both cheeks, about the size of a pigeon's egg when first seen, not painful, and giving the appearance of an attack of mumps. The patient was undersized and mentally retarded. Excision was attempted under diagnosis of sarcoma but histological examination showed early tuberculosis.

Parent's patient reported in 1898 was a man of sixty-one with a previous right otitis media and dental caries. A painful swelling had been present in the left parotid region for three months. A mixed tumor was diagnosed and the swelling removed. The immediate result was left facial paralysis. Pathological examination of the specimen showed the characteristics of tuberculosis, probably of hematogenous origin, because, as in Bockhorn's case, the distribution of the tubercles corresponded with the vessels.



Recovery was complete. Tuberculosis granulation and tubercle bacilli with caseation were found by Lacent in a young man of twenty-nine, with a family history of tubercular infection. Mintz reported, first in Russian and later in a German translation (*Deut Zeits f Chir*, vol lvi, p 290, 1901), a case of a three-year-old-child. A lesion in the left parotid gland proved on excision and examination of a tissue specimen to be tuberculous, all stages of inflammation and caseation being in evidence.

Scheib's case, reported to the German Pathological Society in 1900, was that of a girl of fifteen, who had a swelling in the right cheek which had been painful at night for a fortnight. There was cough with expectoration, loss of appetite and night sweats, temperature  $38.1^{\circ}\text{C}$ . At the opening of Steno's duct was a red protuberance the size of a small pea. The tumor was soft in its centre, and upon being incised exuded pus in which tubercle bacilli were demonstrated. The child died a month later of pulmonary tuberculosis. Post-mortem examination showed thrombosed vessels in the region of the abscess, which led the author to believe the infection to be hematogenous.

American cases seen up to the time this article was written were those of Frank and Wood, which are separately abstracted, and of C. L. Scudder. Scudder's patient was a middle-aged woman, who had noticed a small swelling below the lobule of the right ear of five years' duration. When seen it had reached the dimension of two inches in diameter, being hard and rounded with irregular indurated borders. There was no pain or tenderness on palpation. The mass was removed, with division of Steno's duct and the facial nerve, as these were involved in the disease process. A year and a half later there was no recurrence but facial paralysis was present on the involved side. Microscopical examination of the removed specimen showed numerous small foci in the gland. These were composed of epithelioid, small, round and numerous giant cells, with cheesy degeneration. *Diagnosis*—Tuberculosis. Further cases were published by Borehardt in 1903, Cole in 1904, Puppel in 1905, Danielson in 1907, Fiorvanti in 1910, Nadel and Pouget in 1911.

Carmody's case was a patient at the National Jewish Hospital in Denver, a male aged twenty-four, born in Russia. When first seen there was a hard swelling of the left parotid gland which was diagnosed as inflammatory parotitis due to trauma. This was opened and drained, a few diplococci being found in the evacuations. In dressing this wound another abscess was found walled off from the first, in which pus, containing tubercle bacilli, was found. Soon after there was rapid swelling of the right parotid, and when this was opened, tubercle bacilli were found in the discharge from the wound. The diplococci also present were found to be identical with the organisms causing parotitis. The right side healed completely, but on the left a fistula remained for the two years elapsing before death occurred from pulmonary tuberculosis. No facial paralysis occurred although nearly the entire left parotid gland sloughed away. There was a slight drooping of the right eyelid, but this quickly disappeared.

J. L. Emerit reports a "New Case of Primary Tuberculosis of the Parotid," *Thèse de Paris*, 1923. This thesis does not add anything to the facts set down in the papers previously abstracted. The cases cited are given in greater detail, but nothing concerning pathogenesis nor treatment has been added. The patient was a woman of thirty, who had been aware of enlarged but painless glands in the region of the right parotid for many years. There was a history of excessive cough, and recent loss of weight preceding the manifestation of active symptoms in the swollen parotid region. Excision was undertaken and the specimen removed was histologically proven to be tuberculous. The patient made a good operative recovery and when last heard from had had no recurrence and showed general systemic improvement.

L. Haslhofer, in *Virchow's Arch f path Anat u Physiol*, vol cclvi, p 499, 1927-1928, reports a case where the patient was a woman of forty-five, who for six years had been conscious of a swelling in the left parotid region. It had only recently become painful, for which reason she sought medical advice. There was a history of spondylitis



gland experimentally by injection of bacilli into the parenchyma, as well as by introduction into the duct after paralysis of the secretory nerve

#### SUMMARY

(1) Tuberculosis of the parotid gland is rare and is often mistaken for malignancy, such as syphilis or mixed tumor

(2) Two distinct types are usually found. The first, chronic or fibroid type, which is incapsulated, and may not produce symptoms for months or even years, the second type is acute inflammatory, which is diffuse and runs its course in a few days or a week

(3) Tubercle bacilli gain entrance into the parotid gland by one of three ways. Canalicular, hematogenous or lymphatic, with the first being the most common

(4) Symptoms consist of swelling of the gland, either as a circumscribed or fluctuating tumor, or more diffuse with an occasional soft spot. The second is usually adherent, red, tense, shiny and oedematous. Pain is a late sign and the glands of the neck are not involved

(5) Diagnosis is likely to be difficult unless it is confirmed by biopsy

(6) Prognosis is good, as the affection is purely local

(7) Treatment is purely operative, and even where facial paralysis takes place from injury to the facial nerve, either by disease or operative trauma, there is recovery in most instances

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# METASTATIC EPIDURAL ABSCESS OF THE SPINAL CORD

RECOVERY AFTER OPERATION

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EMERGENCY operations for relief of compression of the spinal cord in cases other than traumatic origin are not common, according to the literature, and are performed usually for infections about the spinal canal. The reported high mortality and discouraging post-operative results probably can be traced to the virulence of the organism and the lowered resistance of the patient, but delayed or neglected operative interference may be a contributory factor.

The literature on this general topic was reviewed by Dandy<sup>4</sup> in 1926. In addition to the ten cases of epidural abscess of metastatic origin, which he cited and tabulated, we have been able to find reports of four cases, namely those of Spiller, Braun, Bensheim,<sup>1</sup> and Pulvirenti (tabulation). For clarity and emphasis, in this paper, consideration has not been given to cases of epidural abscess which were not of metastatic origin, other than to remark that in one case of epidural abscess, due to direct extension of a suppurative process involving neighboring structures, operation was performed and the patient subsequently recovered.<sup>8</sup> Of the fourteen cases of metastatic abscess which have been reported, operation was performed in three. One of the patients died,<sup>5</sup> the outcome is not stated in the second case,<sup>3</sup> and Pulvirenti's patient recovered from the operation and was walking without symptoms within a year. Thus the case reported by Pulvirenti is the only case of metastatic epidural abscess we know of in which diagnosis was made sufficiently early to permit of successful treatment and recovery. We are reporting in detail a case which has been under our care for more than a year and a half.

*Report of Case*—An emotional, large, and obese nurse, aged twenty-eight years, came to the clinic December 8, 1929, complaining of an infection of the nose which had begun that day and which was associated with swelling of the entire face. December 11 she complained of pain in the left ear, examination revealed otitis externa, which cleared up readily under treatment. On the same day nasal discharge was established and roentgenograms of the sinuses were cloudy, improvement set in gradually, and roentgenograms of the sinuses, made December 20, were negative. December 21 a pain suddenly developed in the left costovertebral angle, and was projected along the costal margin to the mid-axillary line. The pain gradually increased in severity, and by December 25 the patient was writhing in pain. She was admitted to hospital at that time as an emergency patient. The temperature was 99.4° F, and the pulse rate, 66 beats a minute. There was tenderness in the left costovertebral angle. Leucocytes numbered 13,500 in each cubic millimetre of

# TABULATION

Summary of Four Cases of Metastatic Extradural Abscess of the Spinal Cord, Reports of Which Have Been Found Since Dandy's Review \*

Case	Reporter and date	Age years and sex	Primary infection	Situation of metastatic extradural infection	Symptoms of onset distribution and type of pain	Paralysis	Bladder or rectum sensation	Common signs of meningeal irritation	Leucocytes in each cm of blood and temperature	Reflexes	Spinal fluid	Duration of life	Clinical diagnosis	Comment
1	Spiller 1921	36 M	Furuncle on neck	Sixth thoracic vertebra	Backache, lower thoracic and upper lumbar vertebrae and legs, flashing burning in crease using severity	Progressive paraplegia complete in one month	Retention with overflow incontinence absent below distribution of seventh thoracic nerves	Spinal rigidity and tenderness, Kernig's, sign positive	Not recorded	Absent	Yellow clotted	Sixty days	Not recorded	Necropsy, leptomeningitis and right empyema
2	Braun 1922	39 M	Injury left scapula followed by local abscess	Entire epidural space	Pain, present but not described	Absent	Not recorded, meningitic	Spinal rigidity and tenderness, Kernig's, sign positive, headache	Leucocytes not recorded, temperature elevated	Negative	Negative upper three, lower staphylococci on culture	More than three days	Meningitis	
3	Bushnell 1926	M	Generalized furunculosis (staphylococcus)	Posterior part of epidural space of lumbar and thoracic vertebrae	Pain, lumbar portion of spinal column and electric shock like	Paraplegia, flaccid, appeared overnight	Retention with overflow incontinence, absent below distribution of second sacral nerves, hyperaesthesia with formation to hypalgesia	Spinal rigidity and tenderness, Kernig's, sign positive, but no headache	6000 on admission, 10000 to 15000 temperature 37.5°C (100.1°F)	Painful, diminished, Achilles definite	Not known	Almost nine days	Septic myelitis	Necropsy, abscess along spinal column right side, phlegmonous abscess of posterior aspect of left psoas muscle with extension of yellow pus along spinal nerves into spinal canal and downward nerve to its emergence from the pelvis
4	Pulvertaft 1921	19 M	Furunculosis left arm (staphylococcus)	Third to fourth lumbar vertebrae	Lumbar pain, paraplegia, lumbar region	Paraplegia, flaccid	Not recorded, diminished in legs	Not known	Not recorded, temperature slightly elevated at onset	Not recorded	Pain observed between third and fourth lumbar vertebrae	Recovered	Acute purulent lumbar abscess	Operation, three months later dismissed with slight spastic gait, eight months later normal central nervous system

\* Our case is not tabulated here since the details are given in the text

blood with 7 per cent neutrophils. The patient gradually grew worse and the temperature fluctuated from  $99.4^{\circ}\text{F}$  to  $103^{\circ}\text{F}$  with corresponding elevation of pulse. The pain became worse and relief was not obtained with opium.

Neurological examination, December 27, gave objectively negative results, except that on flexion of the head on the chest, even to a slight extent, there was marked aggravation of the costovertebral pain. There was a suggestion of Kernig's sign bilaterally, particularly on the left, also on the right, the manoeuvre employed in elicitation of this sign was associated with exaggeration of the pain. The urine was negative to examination. The cerebrospinal fluid was clear and colorless, it was under normal pressure, and the pressure responded promptly to compression of the jugular veins. The Wassermann and Nonne tests of the cerebrospinal fluid gave negative results, and there were two small lymphocytes in each cubic millimetre. December 30 neurological examination was again objectively negative, except for aggravation of the pain on bending the head forward, and on Lascgue's manoeuvre. There was marked tenderness over the spinous process of the twelfth thoracic vertebra and laterally along the course of the twelfth thoracic nerve. Cultures of the urine were negative. Rontgenograms of the thorax and spinal column were of normal appearance. December 31 the patient was unable to void and was catheterized after the bladder had risen halfway to the navel without inducing discomfort.

January 1, 1930, leucocytes numbered 15,600 in each cubic millimetre of blood. The patient complained of pain in both legs and there was involuntary defecation. January 2 she was exquisitely sensitive from head to foot. The neck was not stiff, there was no longer pain on forward flexion of the head on the chest, and there was no tenderness over the spinous process of the twelfth thoracic vertebra. Neurological examination was again objectively negative.

On the morning of January 4 the patient complained of weakness in both legs. By noon, partial flaccid paralysis of both legs had developed, and the tendon reflexes were obtained with difficulty. Also, slight diminution of common sensation over the legs, the posterior aspects of the thighs, and the buttocks was noted. Another spinal puncture, made in the space between the third and fourth lumbar vertebrae, at 1 P.M., under ethylene anaesthesia, revealed clear, lemon-colored, viscid fluid under pressure of 170 millimetres of water, which became opalescent and coagulated on standing. There was no response on compression of the jugular veins. At 2:30 P.M. neurological examination revealed flaccid paralysis and areflexia of both legs (Fig 1). Loss of sense of position in both big toes and of vibratory sensation over the malleoli was noted. There was abolition of sensation of touch, pain, and temperature over the feet and legs, the posterior aspect of both thighs, and the buttocks, and there was partial loss of the latter qualities over the anterior aspect of the thighs. The level at which sensory disturbance began approximately coincided with the inguinal ligaments.

In view of the inflammatory course of the condition, and the increasing leucocyte count, the paraplegia and spinal subarachnoid block, with Froin's syndrome, and the situation and aggravation of the sensory disturbances following lumbar puncture, a diagnosis was made of extradural abscess, and immediate exploration was advised.

At 4:50 P.M., January 2, the spines and laminae of the eleventh and twelfth thoracic and first and second lumbar vertebrae were removed. An epidural abscess ruptured during removal of the bone at the level of the twelfth thoracic vertebra (Fig 2). Thick, creamy pus escaped. After the incision had been carried up to the level of the eleventh thoracic vertebra and down to the second lumbar vertebra, the abscess was found to be fairly well walled off. Reddish granulation tissue, which composed the walls of the abscess, could be easily stripped off the dura. The dura pulsed normally after evacuation of the abscess and removal of its walls.

The entire wound was swabbed with tincture of iodine, Penrose and iodoform drains were inserted, and closure was effected with sutures of silkworm-gut. On account of impaired function of the vesical sphincters, a retention catheter was inserted while the patient was on the table. The entire operation was carried out under ethylene anaesthesia.

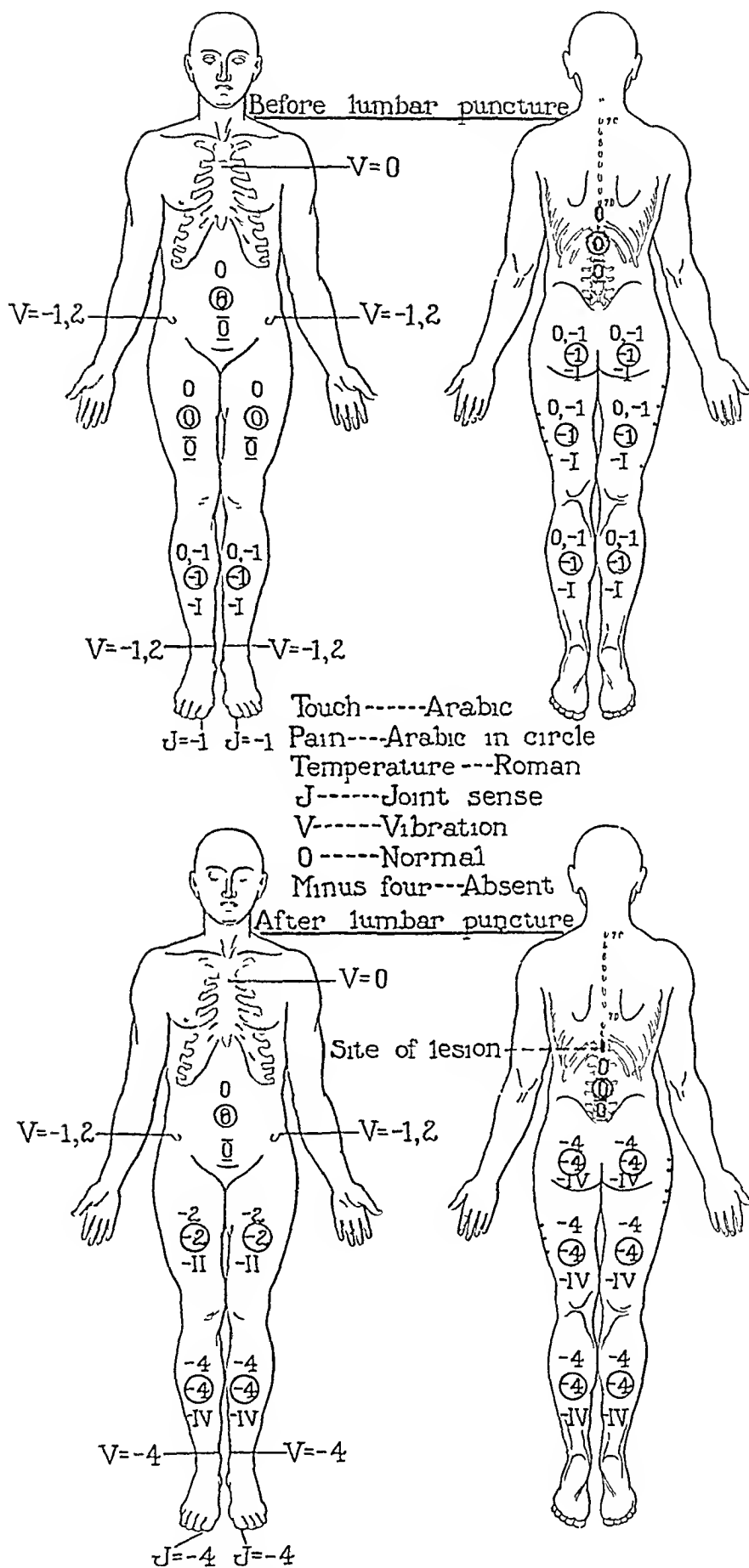


FIG. 1.—The marked sensory change which occurred following lumbar puncture, localizing the lesion

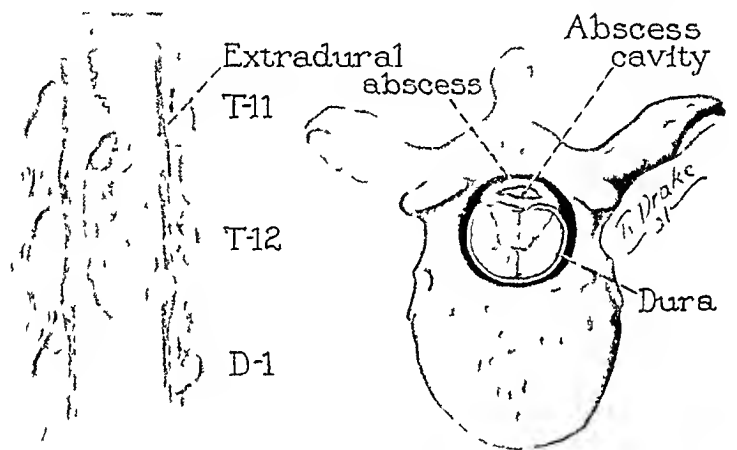


Cultures of the pus and inflammatory tissue removed at operation, made in glucose brain broth and blood agar, revealed staphylococcus

By the morning of January 5 the patient was almost completely relieved of pain, and there was no change in power, sensation or control of sphincters. Blood cultures revealed one to two colonies of staphylococci on blood agar at the end of forty-eight hours. Two days later the patient described the sensation of tingling in both legs and was practically without pain.

January 9 blood cultures were again positive for staphylococcus. Coarse clonic movements of both thighs were first observed January 13. A positive Babinski's sign had appeared two days before.

January 31 the patient complained of feeling very tired and of severe pain on involuntary activity of the legs. Examination revealed paresis of the lower half of the anterior abdominal wall, associated with partial anesthesia which extended as high as the umbilicus. Although the wound was draining profusely, signs of returning compression necessitated removal of the sutures, to allow even more free drainage and daily irrigations. Following this procedure, there was immediate improvement in the patient's condition, and February 13 she complained for the first time of distention of the urinary bladder when the catheter



MAYO CLINIC

FIG 2—Situation and size of abscess

was clamped. At this time there was noted, also, slight return of voluntary control of toes and feet and daily physical therapy was begun.

Following an interval of six days, during which the temperature had been normal, it suddenly rose to 104° F, and a red, indurated, tender, subcutaneous mass was discovered over the trochanter of the right femur. This was incised and drained. The bacteriological report revealed that the pus was of staphylococcal origin. By March 3 the retention catheter could be removed, and the patient began to void voluntarily.

March 15 the patient complained of pain in the region of the left shoulder and again the temperature was elevated. A subcutaneous abscess on the left shoulder was evacuated, the pus containing staphylococcus. After a short interval the wounds healed satisfactorily, with the exception of the laminectomy wound, which slowly granulated and healed over.

By April 25 the patient was able to sit up in a chair, and the positive neurological evidence consisted of considerable loss of power in the muscles of the legs, there was also moderate weakness of the muscles, the tendons of which bound the popliteal space. The patellar and Achilles reflexes were active, and Babinski's sign was present bilaterally. Joint and vibratory sensations were absent in the big toes and at the malleoli, respectively. Slight perception of touch, pain, and temperature indicated return of sensation on both sides, below the level of the umbilicus, and the patient was able to be up and about with assistance or in the orthopaedic "walker." So much had she improved that by May 21

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she was able to walk 100 feet in the hospital corridor. She continued in the hospital until July 14 with daily physical therapy and exercise in the walker. The wounds were healed and the sphincters essentially were competent. She was transferred to a convalescent home to continue with physical therapy and exercise, and by July 26, assisted by two nurses, she was able to walk without the walker.

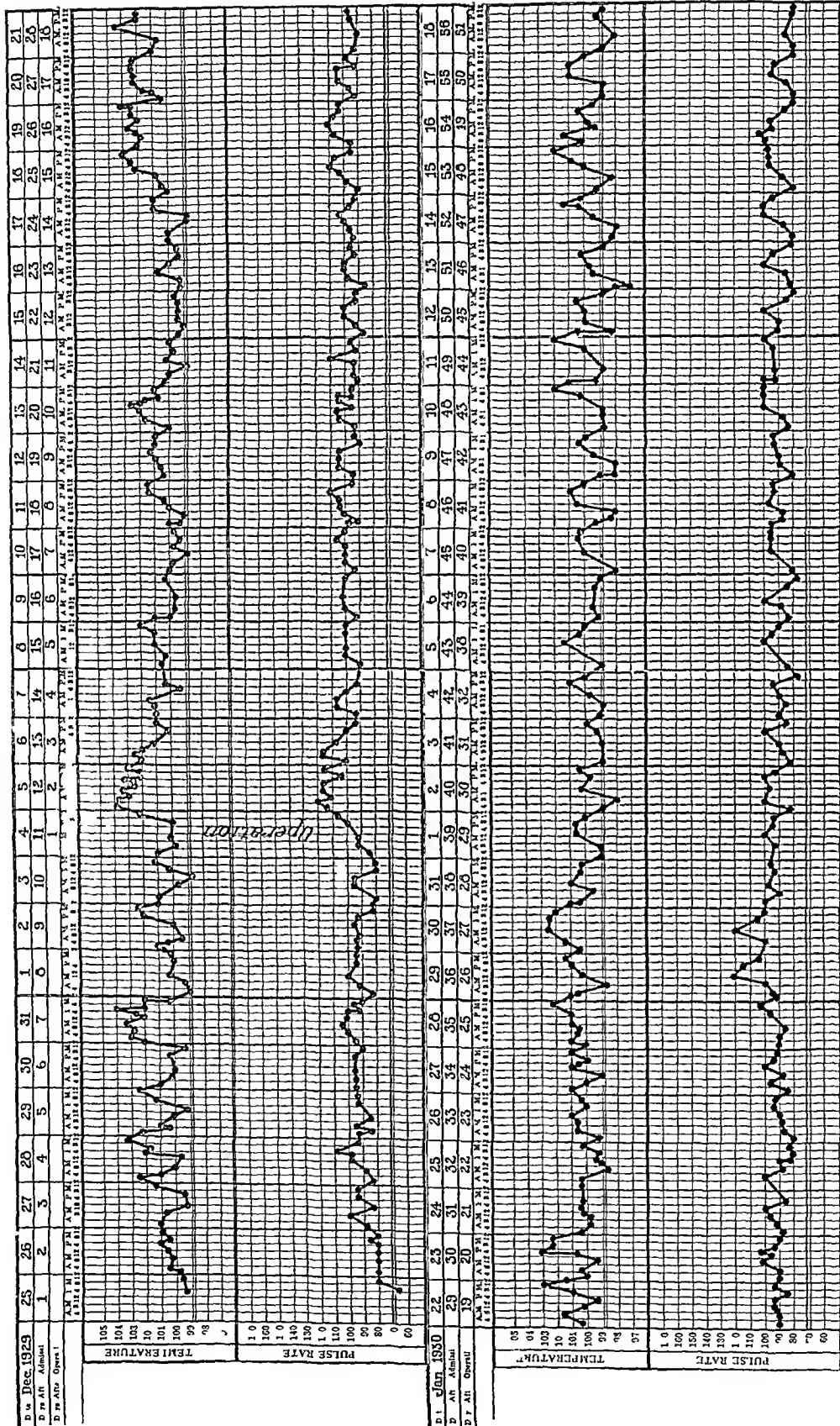
The patient continued to improve, and when examined October 22 there was found to be slight to moderately marked spastic weakness of the muscles of the gastrocnemius group associated with active tendon responses and Babinski's and Chaddock's signs bilaterally. The sense of position had not returned in the big toes and was slightly diminished in the ankles. Vibration was not perceived over the malleoli and only feebly over the iliac crests. Below a line drawn through the umbilicus, common sensation was diminished in acuity. The patient was able to walk with a moderately ataxic, somewhat spastic gait assisted by one attendant.

When the patient was next seen, in November, she could walk without any assistance, and was gradually but progressively improving. By January 26, 1931, she was able to climb stairs holding to the hand rail. March 3 objectively she had shown little improvement since her examination on October 22, 1930, but she was walking better and was able to take 600 steps on the level and to climb up and down twenty-two steps four or five times daily. She returned for observation July 13, 1931, and was found to be markedly improved. Although she was still receiving physical therapy, she was able to walk a considerable distance. Neurological examination gave evidence of slight weakness of the right peroneal muscles and of the plantar flexors of the left foot. There was moderate weakness of the left peroneal muscles and of the dorsiflexors of the big toe. In addition, the deep reflexes of both legs were moderately exaggerated and were associated with sustained ankle clonus and positive Babinski's sign. Common sensation and deep sensation were essentially the same as on October 22, 1930. Gait was somewhat ataxic and spastic. The patient weighed 223 pounds and she was referred to the diet kitchen with the suggestion that she reduce fifty pounds. She was advised also to increase her physical activities. August 25 1931 she weighed 211 pounds and was improving in strength.

*Comment*—There is no clear-cut syndrome characteristic of epidural abscess. In general the clinical picture is likely to be characterized by evidence of an acute inflammatory process associated with symptoms of moderately rapid progressive spinal compression. Pain may be a prominent symptom, sudden in onset and rapidly increasing in severity, in six of the fourteen cases recorded in the literature and in our case, the pain had these characteristics. The pain may be radicular in distribution, as it was in our case. Tenderness over the site of pain was present in six instances in the literature and was very marked in our case.

The development of paraplegia in only eight of the reported cases suggested that the patients were overwhelmed by the infective process before sufficient spinal compression had occurred to render them paralytic, in our case, and that of Bensheim, the paraplegia was flaccid. In eight cases in the literature the status of sensation is recorded, in four cases, sensation was lost at and below the level of distribution of the affected part of the spinal cord, in two cases, sensation was diminished, in one case, it was said to have been negative, and in the remaining two cases, there was hyperæsthesia.

In the beginning of our patient's illness, she was hyperæsthetic. At noon, on the day of operation, examination revealed only slight diminution in the acuity of perception of cutaneous sensation, but following lumbar puncture



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and withdrawal of cerebrospinal fluid, sensation was lost below the level of distribution of the third lumbar segment of the spinal cord and obtunded over the distribution of the first three lumbar segments

Urinary retention developed in our case, and in four of the fourteen cases of which histories are recorded in the literature. Kernig's and Lasègue's signs were reported as being positive in four instances in the literature, but in our case these were not only present but were more pronounced on the side of the pain. The leucocyte count is recorded in only three cases in the literature and ranged from 6,600 to 18,000, whereas, in our case, it was first recorded as 13,500 and subsequently fell to 6,500, only to rise to 19,000 at the time of operation and to 23,000 forty-eight hours thereafter. Elevation of temperature was recorded in seven cases and ranged between  $38^{\circ}$  and  $41^{\circ}$  C, and was manifest in our case, with extremes varying from  $99.4^{\circ}$  to  $104^{\circ}$  F (Fig. 3) which is approximately equivalent to  $37.5^{\circ}$  to  $40^{\circ}$  C. The cerebrospinal fluid was examined in five cases, and in two cases, diplococci were found. In one case<sup>2</sup> a few colonies of staphylococci were observed after culture. In one case<sup>7</sup> the fluid was yellow and clotted, similar to ours. In Pulvienti's case, pus was obtained by spinal puncture. Nine days before operation, the cerebrospinal fluid of our patient was entirely normal, but at 1 P.M. on the day of operation lumbar puncture revealed clear, lemon-colored, viscid fluid which coagulated on standing, there was no response of the fluid in the manometer on compression of the jugular veins.

In three instances in the literature, the infective process involved the greater part of the entire epidural space, in six others and in our case, the lesion was in the thoracic or thoracolumbar regions, and in one case the third and fourth lumbar segments were involved. The duration of life of the patients in ten of the fourteen cases reported in the literature is recorded. Braun's patient lived more than three days, Bensheim's patient almost nine days, and Spiller's patient lived sixty days. Pulvienti's patient recovered.

The symptoms group themselves into two categories. There are those to be associated with inflammatory disease, such as headache, general malaise, fever, and leucocytosis, with or without evidence of bacterial invasion of the cerebrospinal fluid. In the entire group of cases, there is evidence of infection at some site more or less distant from the spinal column. In the second group of symptoms are those suggestive of irritation of one or more spinal nerve roots. The outstanding symptom in this group is pain, which is often of sudden onset and increasing severity, and which may manifest the characteristics of a so-called root pain. This may be followed by such evidence of spinal compression as weakness, diminished sensation, and failure of function of the sphincters.

### SUMMARY

In a review of fourteen cases of metastatic epidural abscess of which the histories are recorded in the literature, only one was discovered in which the

patient had recovered. An additional case is reported, in which the condition was diagnosed, the patient operated on, and recovery took place.

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# PULMONARY EMBOLISM AND INFARCTION

## ANALYSIS OF SIXTY-FOUR VERIFIED CASES

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THIS study is based on sixty-four cases of pulmonary embolism with or without infarction coming to necropsy in the Albany Hospital from 1921 to 1929 inclusive. The incidence of this much-feared complication varies in different statistics. Petición<sup>1</sup> comments on the increased frequency of these cases during the last twenty-five years. Killian<sup>2</sup> noted that the percentage incidence of all cases of fatal pulmonary embolism gradually increased from 0.085 per cent in 1919 to 0.3 per cent in 1920. The primary site of the thrombus may occur anywhere in the venous circulation. It may even be primary in the lung itself (autochthonous). Frothingham<sup>3</sup> reported a very interesting case of autochthonous thrombosis, resulting from acute lesions in the arteries where the thrombosis began in the smallest branches of the pulmonary arteries and propagated centripetally toward the larger branches, producing multiple small infarctions of all ages.

As stated by Aschoff,<sup>4</sup> thrombosis is a function of a number of variables. Much has been written on the importance of the various factors which enter into the formation of a thrombus. The exact mechanism producing more or less immediate death when only a small portion of the pulmonary circulation is obstructed by an embolus is still unknown. It appears that the circulatory cessation precedes the respiratory. Mann<sup>5</sup> has been able to produce death experimentally only by a more or less complete blocking of the pulmonary circulation. Haggart and Walker<sup>6</sup> experimentally showed that total pulmonary occlusion sets up a severe and immediate reaction, as evidenced by a rapid and marked dilatation of the heart. The minute volume output of the heart becomes less. The pulmonary pressure rises sharply, then gradually falls toward zero, whereas the systemic blood-pressure begins to fall immediately and does not recover, while the respirations become irregular and shortly afterwards cease altogether. In the production of multiple embolism by injecting large amounts of potato starch granules into the jugular vein of goats, Dunn<sup>7</sup> showed that the venous pressure rises while the arterial falls, followed by death. In cats<sup>6</sup> from 52 to 66 per cent and in dogs<sup>8</sup> 75 per cent of the pulmonary circulation can be shut off without producing significant variations in the general circulation. When one pulmonary artery is occluded by ligation, the pulmonary blood-pressure rises but there is no effect on the carotid pressure and on the rate, output and size of the heart—Underhill,<sup>9</sup> Haggart and Walker, Welch,<sup>10</sup> Plummer,<sup>11</sup> Gerhardt.<sup>12</sup> Experimentally Schlaepfer<sup>13</sup> found that the lung on the intact, non-ligated side

underwent a compensatory mechanism—chronic dilatation of the arterioles and capillaries and dilatation of all alveoli, but no fibrosis. The lung on the ligated side showed marked stasis of blood, diapedesis, and finally fibrosis. Kawamura<sup>14</sup> had already long ago noted this extreme connective-tissue proliferation of the lung on the ligated side and its subsequent marked contraction.

At the present time, more and more interest is being paid to the operative treatment of embolism of the lungs by the Trendelenburg operation as more and more successfully treated cases are being reported—Meyer,<sup>15</sup> Matas,<sup>16</sup> and Nystrom<sup>17</sup>. Even after the successful performance of Trendelenburg's operation, the risk of new emboli is very great, and Westerborn<sup>18</sup> warns us that this should be kept constantly in mind in the post-operative treatment of the patient and the estimation of the prognosis.

*Incidence*—From 1921 to 1929 inclusive, sixty-four cases of pulmonary embolism came to necropsy in the Albany Hospital. These were divided as follows—post-operative, twenty-five cases, post-traumatic, three cases, medical, thirty-six cases. During this same interval, there were performed 810 necropsies which gives a necropsy incidence for embolism of 7.9 per cent. There was a total of 3,031 deaths in the hospital or a mortality incidence for embolism of 2.1 per cent. There was admitted to the hospital a total of 62,935 patients. The morbidity from pulmonary embolism will then be 0.102 per cent, or about one per 1000 hospital population. From Table I it is seen that the percentage autopsy incidence of embolic cases varies from a low 0.65 per cent to a high 14.52 per cent.

TABLE I  
*Incidence of Embolism in Necropsied Cases*

Author	Year	Number of necropsies	Number of embolic cases	Percentage of embolic cases
Rupp	1921	12,971	657	5.07
Hedinger and Christ	1922	3,000	436	14.52
Naegeli	1925	4,916	43	0.87
McCartney	1927	9,275	73	0.79
Stohr and Kazda	1928	20,654	134	0.65
		714	13	1.82
		2,664	29	1.08
Farr and Spiegel	1929	1,116	30	2.68
Gruber	1930	15,867	271	1.71
Hosoi	1931	810	64	7.90

There were thirty-five males to twenty-seven females or 1.4:1 for embolism. The ratios for total admissions were 0.9:1, for total deaths, 1.5:1, and for necropsies, 1.6:1. This means that more males die and are autopsied in this hospital. Hence, sex has probably no significance in the etiology of embolism.

Among the men, 61 per cent of the cases occurred between fifty-one and seventy and among the women, 73.3 per cent between forty-one and fifty

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years of age. As shown in Chart 1, the age incidence of embolic cases suddenly increases from forty years on for males with the mode at fifty-one to sixty years and from thirty on for females with the mode at forty-one to fifty years. Similarly the highest age incidence in Axhausen's<sup>19</sup> cases was in the sixth decade. Zunhelle<sup>20</sup> found the majority of his gynecological cases with embolism lay between thirty-six and fifty-five years with the mode at forty-one to forty-five years. In de Quervain's<sup>21</sup> cases, the highest incidence was between fifty and sixty-nine for both male and female. About two-thirds of all cases of both Killian<sup>2</sup> and Gruber<sup>22</sup> occurred after fifty years of age. On the other hand, Hampton and Wharton<sup>23</sup> found only one of their fifty-one embolic gynecological cases above fifty years of age and 66 per cent between twenty and forty years.

As regards the seasonal influence, no reliable conclusions can be drawn

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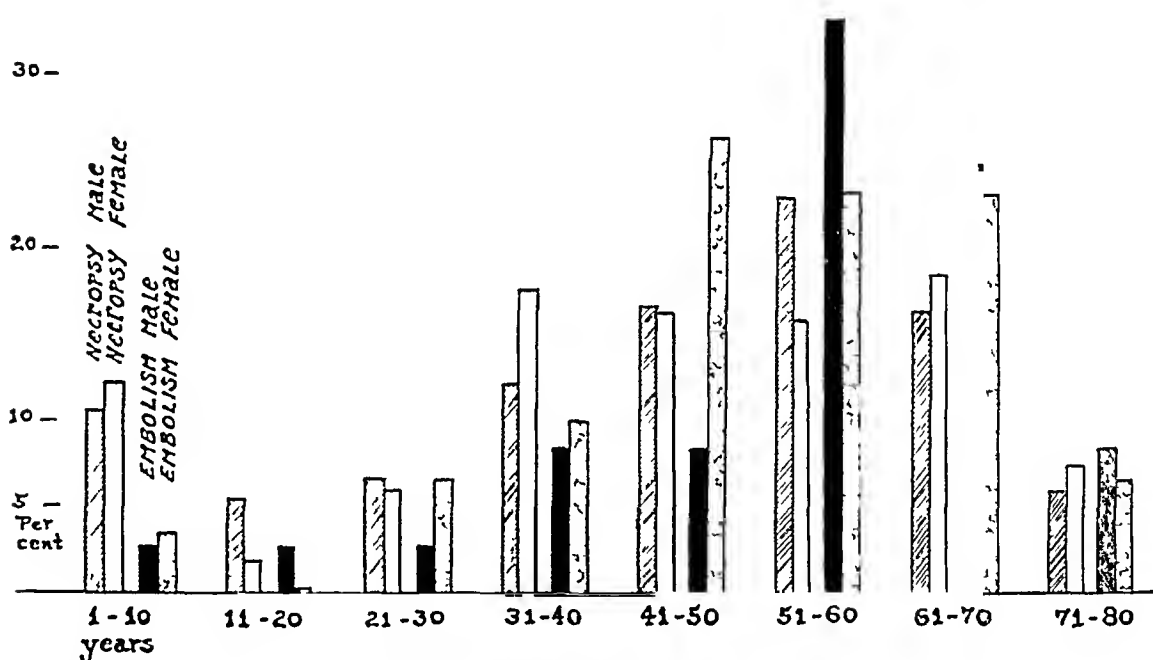


CHART 1—Histogram of percentage frequency of necropsies and pulmonary embolism in each decade for male and female

from this study. De Quervain found the highest incidence in February and March, but the percentage figures were generally so irregular that nothing definite was obtained. On the other hand, in Geissendorfer's<sup>24</sup> cases, the highest incidence was in May and the lowest in March. The highest percentage in the Albany series occurred in mid-winter and mid-summer, but we find that the greatest percentage of necropsies also occurred in the summer and winter months. This shows that, as Gunther,<sup>25</sup> and Hosoi and Alvarez<sup>26</sup> have pointed out, every percentage figure should be corrected by a factor dependent upon the distribution of the group from which the cases studied were obtained.

*Post-operative cases of embolism*—Any study of post-operative embolism



must necessarily take into consideration the incidence of thrombophlebitis which may or may not lead to embolic phenomena. There were forty-seven cases or 0.16 per cent of post-operative phlebitis including eight cases of pulmonary infarction, forty-four of which improved and three died. These three did not come to necropsy, but one gave typical symptoms of cerebral embolism and one, pulmonary infarction. Twenty-four of these cases followed general surgical operations and twenty followed gynecological operations. A large majority of these had thrombophlebitis of the femoral veins. Cordier<sup>27</sup> from a study of 232 collected cases concluded that phlebitis occurs in about 2 per cent of all abdominal operations.

TABLE II

*Incidence of Femoral Thrombophlebitis Among Post-operative Cases*

	Right	Left	Both sides	Not stated	Total
General surgery	4	15	1	1	21
Gynecology	8	10	2	—	20
	12 (29.3%)	25 (61.0%)	3 (7.3%)	1 (2.4%)	41

Table II shows that 61 per cent of the post-operative femoral thrombophlebitis occurred on the left side. Sixty-four per cent of the eighty-seven cases of phlebitis reported by Brown<sup>28</sup> occurred in the left leg. In Hampton and Wharton's 205 cases, the vessels of the left lower extremity were involved in 66 per cent. Cordier found that in about 92 per cent of 232 collected cases the phlebitis occurred in the left saphenous or femoral veins. Various theories have been brought forth to explain this left-sided preponderance. A slowing of the venous stream on the left side has been stressed by many, especially when left-sided femoral thrombophlebitis occurs after right-sided abdominal operations. This slowing is believed to be caused by the greater length and obliquity of the left iliac vein, by pressure of the distended recto-sigmoid on the iliac veins, and by pressure of the right common iliac artery. McMurrich<sup>29</sup> found that valves or adhesions within the common iliac veins were much more frequent on the left side than on the right, dividing the lumen of the vein into two passages. Stasis and slowing of the blood-stream have been proved experimentally that *per se* they cannot produce thrombosis. The blood in the artery or vein included between two sterile ligatures was found fluid for hours, days and weeks by Hunter,<sup>30</sup> Durante,<sup>31</sup> Glenard,<sup>32</sup> Baumgarten,<sup>33</sup> Raab,<sup>34</sup> Senftleben,<sup>35</sup> and Miller and Rogers.<sup>36</sup>

Among the autopsied cases of post-operative thrombophlebitis, there were only three cases in which thrombosis of the iliac and femoral veins was demonstrated. All three cases were non-gynecological. In two, the left common iliac vein was involved, and in one the right iliac with peripheral extension. In their studies on experimental thrombophlebitis and lymphatic obstruction of the lower limb in dogs, Homans and Zollinger<sup>37</sup> concluded that the basic lesion is always in the common or external iliac vein, however far the thrombophlebitis may extend peripherally.

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Clark<sup>38</sup> found that femoral thrombophlebitis occurs with startling regularity after the eighth day, appearing most frequently about the fifteenth day after operation. Schenck's<sup>39</sup> cases occurred from the sixth to the twenty-second day post-operative. In the cases here presented, the onset post-operatively ranged from the seventh to the twenty-eighth day, 50 per cent occurring between the eleventh and fifteenth days.

According to Mahler,<sup>40</sup> the diagnosis of thrombosis can be made with certainty only by a study of both the pulse and temperature curves. He particularly stressed the step-like increase of the pulse, associated with a normal temperature, which takes place several days before the thrombosis becomes evident. Payr<sup>41</sup> often saw isolated rises of pulse or temperature but concluded that they were of doubtful value. Hampton and Wharton found that thrombosis of a large peripheral vein may be present without any local signs or symptoms whatever. They, however, observed in almost all their cases a low protracted febrile course, 99 to 100° F. in the convalescence preceding the infarction and this they attributed to the presence of a thrombus. Glynn<sup>42</sup> stated that



FIG 1



FIG 2

FIG 1—Photograph of heart and lungs with the pulmonary artery opened. An embolus is coiled up in typical fashion in the right and left pulmonary arteries.

FIG 2—Photograph of emboli removed from the main pulmonary artery and the right ventricle and reconstructed as closely as possible to the probable original form. This composite picture gives an idea of the size, extent, and branching of the original thrombus which may have started in the iliac vein and its tributaries.

the development of primary pulmonary thrombosis was often suggested by the slight rise in pulse rate without corresponding rise in temperature. In the Albany series, where there was no infection of the operative field and where the respiration was normal and the temperature between 98 and 99, the pulse ranged between 80 and 116. In those clean operative cases where the temperature reached 100 or even 103 temporarily, the associated pulse rate was as high as 140 and the respiration rose to between 30 and 40. The discrepancy noted above between temperature and the pulse became noticeable in some of these cases when the temperature fell down to within normal limits. This discrepancy is certainly suggestive but only relative, since there were cases where the pulse remained at normal levels.

It has not always been possible to determine at necropsy the location of the thrombus formation which gave rise to the pulmonary embolism. Often

the only clue that the thrombus may have originated in the femoral, iliac or other large veins is the large size of the embolus or its coiled-up appearance (Fig 1), the branching structure of which may be demonstrated by floating the embolus in water. Sometimes, by reconstruction of the embolus, it has been possible to surmise that a large vein was the source of the embolus (Fig 2)

Table III

Author	Year	Incidence of Post-operative Embolism			Type of Operation
		Number of operations	Embolism No	cases %	
Cutler and Morton	1917	3,490	6	0.17	General surgery
Hampton and Wharton	1920	21,000	51	0.24	Gynecological only
Eisenreich	1920	3,981	12	0.30	Gynecological only
Rupp	1921	22,689	51	0.26	General surgery
		2,769	10	0.36	Gynecological only
Cutler and Hunt	1922	1,604	2	0.12	General surgery
de Quervain	1925	56,020	249	0.46	General surgery
Naegeli	1925	15,343	21	0.67	General surgery
Farr and Spiegel	1929	12,813	22	0.171	General surgery
					(blunt dissection)
		12,615	21	0.167	General surgery
					(fine dissection)
Fuller	1930	1,478	10	0.67	General surgery
Killian	1930	22,413	44	0.19	General surgery
Geissendorfer	1930	20,960	46	0.22	General surgery
Hosoi	1931	22,240	27	0.12	General surgery
		6,265	6	0.10	Gynecological only

*Incidence of post-operative embolism*—As shown in Table III, the percentage incidence of post-operative embolism varies approximately from 0.12 to 0.67 among the general surgical patients and from 0.10 to 0.36 after gynecological operations. Cutler and Morton<sup>43</sup> observed that one in every 581 operations is liable to be followed by pulmonary embolism. Ochsner and Schneider<sup>44</sup> found only one death from pulmonary embolism in every 2,385 operations. The table shows that the incidence of embolism in the Albany Hospital is among the lowest when compared with that of other institutions. Between the years 1921 and 1929 inclusive, there were performed 22,240 general surgical operations and 6,265 gynecological operations. This gives a post-operative incidence for embolism of 0.12 per cent for general surgical patients and 0.10 per cent for gynecological patients, or a total of less than 0.12 per cent for the whole hospital. Contrary to what has been found in other clinics, embolism occurs less frequently among the operated gynecological patients as among those admitted to general surgery in this hospital. From a personal experience of 1000 consecutive cases, Dannreuther<sup>45</sup> found an incidence of 0.4 per cent for thrombophlebitis and 0.3 per cent, for embolism after pelvic surgery. Rupp<sup>46</sup> gave an incidence of thrombophlebitis of 0.3 per cent among 2,769 operations on the female genital tract, Morley,<sup>47</sup> 0.62 per cent among 1,756 gynecological operations, Burnham,<sup>48</sup> 0.81 per cent

among 11,655 operations, and Hampton and Wharton, about 1 per cent among 21,000 gynecological operations. Schenck<sup>49</sup> found that among 49,161 gynecological operations reported by twelve writers, there were 566 instances of thrombosis or 1.15 per cent.

It is generally believed that operations on the myomatous uterus are notorious for their thrombotic and embolic complications. Of the twenty cases of post-operative thrombophlebitis, nine or 45 per cent had a myomatous uterus. Of the five necropsied gynecological cases, only one had multiple myomas. Among Cordier's 232 cases, phlebitis followed hysterectomy for fibroids in 30 per cent of the cases. Thirty-three and seven-tenths per cent of Hampton and Wharton's 205 cases were operation on for myomas of the uterus. However, von Lichtenberg<sup>50</sup> found only 0.8 per cent with pulmonary complications and 0.7 per cent with embolic phenomena among the 1,479 operations for myomectomy. Also Schenck<sup>39, 49</sup> found that following 3,204 myoma operations reported by eight writers, there was thrombosis in only 3 per cent. Yet, 39.6 per cent of his own forty-eight cases of phlebitis followed hysteromyomectomy and myomectomy. There were only two cases (0.4 per cent) of embolism following 451 myoma operations at the Munchener Frauenklinik.<sup>51</sup> In Klein's<sup>52</sup> series of 730 myoma operations, thrombosis occurred in 3.3 per cent. Among 654 operations for myoma, Zurhelle found eighteen (2.75 per cent) cases of thrombosis and ten (1.5 per cent) of pulmonary embolism. Thus, it is seen that in the larger statistics, the incidence of thrombosis after operations on the myomatous uterus averages about 3 per cent, which is not a high figure.

Table IV shows the types of operations which were followed by pulmonary embolism with or without infarction among the twenty-five cases. Twenty were performed under general ether anæsthesia, three under local, and two under spinal. Three were entirely non-abdominal—two radical breast amputations and one resection of the knee. There were five operations in the upper abdomen and seventeen (68 per cent) in the lower abdomen. This is in agreement with the general belief that lower abdominal operations are more likely to be followed by thrombotic and embolic phenomena than those on the upper abdomen. In Henderson's<sup>53</sup> statistics, 44 per cent of the abdominal operations were performed in the upper portion and 51.6 per cent in the lower. Of the forty-three fatal pulmonary embolism cases of Naegeli,<sup>54</sup> 19 per cent had operations in the upper abdomen, whereas in 51 per cent the operations were gynecological, or in the lower abdomen. Lister's<sup>55</sup> statistics suggest that once an incision is made through the anterior abdominal wall, the liability to embolism depends on the age of the patient and not on the actual operation performed. Fuller<sup>56</sup> states that the length of the operation does not seem to bear any intimate relation to the occurrence of post-operative pulmonary complications.

*Trauma*—The amount of trauma, which may occur depending upon the type of the operation and upon the surgeon, has been stressed by many as being of etiologic importance in thrombosis and embolism. Clark<sup>38</sup> believed

TABLE IV  
Necropsied Cases of Post-operative Pulmonary Embolism

No	Sex	Age	Operations	Infection at operative field	Days post- operative	Source of embolus— veins	Pulmonary infarction— lobes
1	F	79	Colostomy	Post-operative peritonitis	5	Undetermined	Left lower lobe
2	M	70	Suprapubic cystostomy	Clean	9	Vesical veins	None
3	F	68	Radical breast amputation	Clean	32	Bilateral femoral	Right lower and upper
4	M	74	Inguinal herniotomy	Clean	9	Undetermined	Right and left lower
5	M	26	Appendectomy for ruptured gangrenous appendix	Local peritonitis	8	Undetermined	None
6	F	54	Panhysterectomy, bilateral salpingo-oophorectomy, appendectomy	Clean	11	Small pelvic	None
7	F	6½	Appendectomy for ruptured appendix	Peritonitis with walled-off ab- scesses	3	Thrombi in many sub- peritoneal veins	None
8	F	52	Appendectomy	Clean	2	Undetermined	Lower
9	F	43	Panhysterectomy, bilateral salpingo oöphorectomy	Clean	10	Undetermined	None
10	F	45	Supravaginal hysterectomy, bilateral salpingo-oophorec- tomy, perineorrhaphy, appendectomy	Clean	7	Undetermined	None
11	M	72	Suprapubic prostatectomy	Acute cystitis	42	Undetermined	Right lower
12	M	35	Appendectomy	Clean	8	Prostatic plexus, exter- nal and internal iliacs	Right lower
13	M	61	Cholecystotomy followed by biliary fistula	Post-operative peritonitis with abscesses	3	Undetermined	Right lower
14	M	76	Gastroenterostomy	Clean	2	Right femoral	Left lower
15	F	57	Radical breast amputation	Clean	24	Iliac veins	Left upper and lower
16	M	60	Suprapubic cystostomy	Clean	31	Undetermined	Right lower
17	M	56	Colostomy	Clean	2	Undetermined	Right lung
18	M	58	Mickulicz operation	Clean	10	Pelvic veins	None
19	F	66	Cholecystotomy, bilateral salpingo-oöphorectomy, ap- pendectomy	Clean	24	Left femoral	Left lung
20	F	61	Panhysterectomy, bilateral salpingo-oöphorectomy, um- bilical herniotomy, appendectomy	Post-operative peritonitis	6	Undetermined	Left lower
21	M	53	Appendectomy for gangrenous appendix	Local peritonitis	4	Undetermined	Lower
22	F	67	Cholecystotomy with drainage, ventral herniotomy	Clean	17	Undetermined	None
23	F	59	Ventral herniotomy, with lipectomy	Clean	15	Epigastric and iliac	Right lower
24	M	61	Marsupialization for pancreatic cyst	Clean	20	Undetermined	None
25	M	40	Resection of knee	Clean	12	Undetermined	Left lower

that trauma caused by heavy retraction of the abdominal wall with retractors starts up a propagating thrombotic process in the deep epigastric veins. Yet, as shown in Table III, Farri and Spiegel<sup>57</sup> could find no difference in the incidence of pulmonary embolism after operations performed under blunt dissection or under fine dissection. McLean's<sup>58</sup> experimental work on etherized dogs is most interesting. He found that the crushing of a vein will not cause a clot at the point of crushing. The procedure can be repeated in forty-eight hours and still a clot will not form at the site. He concluded that endothelial damage is not *per se* a cause of thrombosis, thus confirming the work of Glénard<sup>32</sup> on traumatized arteries.

*Infection* — Infection has been given much prominence in the causation of thrombo-embolic phenomena. From Table IV, it is seen that seventeen (68 per cent) of the twenty-five cases can be regarded as being clean cases. In the remainder the operative field was found grossly infected or became so post-operatively. In one case, the operative field was clean but a pyelonephritis was present. From a study of the necropsy material of 20,654 cases, Stohr and Kazda<sup>59</sup> concluded that infection appears to play a secondary rôle in the causation of local thrombosis and that infection has no noteworthy significance in the origin of distant thrombosis. In 1887, Weigert<sup>60</sup> frequently found masses of micrococci inside marantic thrombi. In Welch's laboratory, Harris and Longcope<sup>61</sup> (1900) examined bacteriologically forty-four thrombi and demonstrated the presence of bacteria in thirty-four of these. Rosenow<sup>62</sup> in 1927 isolated the diplo-streptococcus from the embolus in each of the five necropsied cases of post-operative pulmonary embolism, following thrombosis of the iliac or femoral veins. There is no doubt that infection can be an important factor in the causation of post-operative thrombosis, but it does not explain those thromboses frequently occurring in cases without manifest infection. In none of the sixty-five cases of Moller<sup>63</sup> was it possible to demonstrate bacteria in the emboli. Indeed, McLean<sup>58</sup> found that crushing a vein with the subsequent introduction of a twenty-four-hour bouillon culture of staphylococci and again crushing the vein to grind the staphylococci into the walls of the vein will not produce a clot or thrombus at the site of the crushing. But he found that clots were formed if he introduced an infected thread into the vein or artery and allowed the thread to remain suspended in the lumen of the vessel, whereas no clots were formed if he repeated the experiment with sterile threads. He believed that infection and necrosis, or the toxins derived from an infectious and necrotic process, are probably the most important factors in the production of a thrombus.

*Localization of embolus* — In the cases here reported, 42 per cent of the post-operative emboli lodged in the lower lobes, more often on the right in the ratio of almost 2 : 1, 42 per cent in the pulmonary artery or in one of its two main branches, the right being favored, 4 per cent were multiple. The upper and middle lobes were not affected in these post-operative cases except in those with multiple embolism. Moller's<sup>63</sup> ratio of right to left lung

involvement was 5 3 In Tiedemann's,<sup>64</sup> Rupp's,<sup>65</sup> Hedinger and Christ's,<sup>66</sup> and de Quervain's<sup>21</sup> statistics, there was a marked predilection for the lower lobes, especially the right lower lobe Welch<sup>67</sup> in 1899 wrote "The course followed by an embolus in its travels is determined by purely mechanical factors of which the most important are the size, form, and weight of the plugs, the direction, volume, and energy of the carrying blood-stream, the size of branches and the angles at which they are given off, and the position of the body and its members In accordance with these principles, we find emboli in the lower lobes of the lungs oftener than in the upper, and in the right lung oftener than in the left, the right pulmonary artery being larger than the left" Martin<sup>68</sup> ingeniously produced a thrombus in the femoral veins of dogs by injecting a mixture of saline, liquor ferri sesquichloridi and barium sulphate, loosened the thrombus thus formed, and watched it travel to the lungs under the Rontgen-screen The thrombus at first traveled slowly through the inferior vena cava, but much more rapidly after it had passed the level of the diaphragm, then it was churned up in the right ventricle and rushed onward into the pulmonary artery and its branches, particularly in the lower lobes The upper lobes remained relatively free

TABLE V

*Onset of Post-operative Pulmonary Embolic Symptoms*

Weeks	1	2	3	4	5	6	Undetermined
Per cent	32	32	16	8	4	4	4

*Days post-operative*—Table V shows the number of post-operative days elapsing before the pulmonary embolic symptoms were first noticed In three non-infected cases, the pulmonary embolism occurred on the second day Sixty-four per cent of the cases occurred in the first and second weeks post-operatively One case each occurred in the fifth and sixth weeks Examination of the autopsied cases of pulmonary embolism reported by Farr and Spiegel showed that, on the average, the onset of fatal symptoms was on the eleventh day with the limits at one to twenty-seven days The average for the cases of Miller and Rogers<sup>36</sup> was also the eleventh day Sixteen out of the nineteen embolic cases of Zuhelle occurred in the first and second weeks In de Quervain's large statistics, there were two peaks in the incidence of embolism based on the interval between operation and death The first peak occurred during the first week and the second in the middle of the second week In Henderson's 267 verified cases, the average interval between operation and death was fourteen days Seventy-five per cent of Hampton and Wharton's cases occurred during the second and third weeks

It is to be remembered that operation may loosen a pre-formed thrombus so that embolism, generally of the septic type, may occur at the time of the operative procedure Abbott<sup>69</sup> stressed this danger when he stated that too little attention has been given to the thrombus which may be disturbed or infected by operations or may materially affect the prognosis of the operation Cutler and Hunt<sup>70</sup> believe that small emboli can actually take place during

operation, as they have known patients to come out of the anæsthetic with chest pains, demonstrable friction rub and spitting up of blood-tinged sputum. They also believe that in the majority of cases, the various types of post-operative pulmonary complication are due to embolism from the operative field and not due to aspiration of infected material through the respiratory passages. Holman<sup>71</sup> found it impossible to produce a pulmonary abscess by the introduction of septic material into the bronchus. He concluded that post-operative pulmonary suppuration probably has its origin more often in the setting free of a septic embolus into the blood-stream by operative measures.

Death may be instantaneous after embolism or may not occur until some time later. The duration of symptoms from onset of pulmonary symptoms to death varied from sudden to ten days, except in one patient who lingered on until the twenty-sixth day when the third shower of emboli carried him off. Twenty per cent of the cases died suddenly. Sixty per cent died between the first and third days.

*Post-operative blood changes*—Allen<sup>72</sup> found in twelve patients a sharp increase of fibrinogen, a sharp prolongation of prothrombin time, and leucocytosis. The blood calcium showed only slight variations with a tendency toward a decrease. The number of platelets, the cholesterol, the bleeding time, and the coagulation time did not show definite changes. On the other hand, Andrews and Reuterskiöld<sup>73</sup> after intensive post-operative blood-chemical studies for twenty-four and thirty-six hours after operation found no significant changes in the leucocytes, blood-pressure, temperature, pulse, blood-sugar, water content of the blood, chlorides or carbon dioxide. In every case, there was an enormous rise in the calcium in the blood, accompanied in all severe cases by an equally large fall in the potassium so that the potassium-calcium ratio often fell to below one. It is still unsettled as to how these blood changes may affect the incidence of post-operative thrombosis and embolism. Welch<sup>74</sup> could see no definite and constant relation between the amount of fibrin obtainable from the blood or the rapidity of its coagulation in the test tube and the occurrence of thrombus in human beings.

*Influence of diet*—It has been suggested by Mills<sup>75</sup> and by Mills and Necheles<sup>76</sup> that the protein in the diet of post-operative patients may be an important etiological factor in the production of thrombosis, as the tendency to thrombosis appears during convalescence, usually shortly after the patient has begun to partake of a full diet. They found experimentally an increased coagulability of the blood following protein intake and lack of such effects with carbohydrate or fat. They observed that this marked shortening of blood-clotting time was intimately associated in time and degree with the specific dynamic action of protein. From the monographic work of Benedict and Carpenter,<sup>77</sup> it is well known that the specific dynamic action is greatest and more prolonged after protein ingestion than after carbohydrate or fat ingestion. It is interesting to note that this specific dynamic action effect with its increased cellular activity is manifested also by a more rapid healing of



wounds in dogs (Clark<sup>78</sup>), and in white rats (Harvey and Howes<sup>79</sup>) than with other foodstuffs, by a more rapid rate of blood-regeneration in dogs (Hooper and Whipple<sup>80</sup>), and by marked hypertrophy of the kidneys (Osborne and associates,<sup>81</sup> Jackson and Riggs,<sup>82</sup> and Smith and Moise<sup>83</sup>) By animal experimentation, Bancroft, Kugelmass and Stanley-Brown<sup>84</sup> found that the tendency to bleed or clot are definitely influenced by diet, and that lipins and globulins are the source of the blood-clotting substances, initially arising from the daily dietary

Of the twenty-five post-operative cases in the series here reported, fourteen were on a general diet at the time of onset of symptoms, eight on a soft diet, and three on liquids All those on soft diets and liquids were given plenty of custards, ice cream, malted or plain milk, egg nog, beef or clam broth, and orange albumin—all rich in proteins or protein derivatives The protein in the diet may have some etiologic relationship to post-operative thrombosis and embolism, but cannot be considered as a dominant factor since all post-operative patients in this hospital are given relatively the same type of diet and the incidence of thrombosis in these patients is very low

*Influence of obesity*—Obesity is generally believed to predispose to thrombotic and embolic phenomena Snell<sup>85</sup> found that of the 156 post-operative deaths in obese persons, forty or 25.6 per cent were due to fatal embolism and that pulmonary embolism was about three times as frequent a cause of death in the obese group as in the control group However, the average age of his obese group was fifty-five, so that the age factor strongly comes into consideration In the cases here reported, seven of the twenty-five post-operative embolic deaths were in definitely obese patients, but all seven cases were above fifty years old, ranging from fifty-three to seventy Extensive, well-controlled statistics will be necessary before any definite etiologic importance can be attached to obesity

*Influence of exertion in setting free a thrombus*—One often observes the dramatic suddenness with which embolism may make itself evident, especially about the time when the patient is allowed out of bed It is to be observed that in our series, 64 per cent of the cases occurred in the first and second weeks post-operatively in other words, these patients have been sitting up in bed, in a wheel-chair, or up and about the wards Fatal embolism can occur during sleep One patient who had spent a comfortable evening and morning, suddenly woke up from an afternoon nap with extreme dyspnoea, rapidly became unconscious, and died ten minutes later Another patient awoke with a scream, called for air, became cold and clammy, and expired Farr and Spiegel profess skepticism as to any essential significance of straining at stool, sitting up in bed, and other types of exertion in precipitating embolism, because they found in several instances the obvious age of the pulmonary embolus precluded such interpretation

*Infarction*—We know that not all cases of pulmonary embolism are associated with infarction Welch, in 1899, stated that hæmorrhagic infarction occurs during broken compensation of cardiac disease, weakness of the right

heart, fatty degeneration of the heart, general feebleness of the circulation, pulmonary emphysema and infective diseases. Welch and Mall<sup>86, 87</sup> showed experimentally that given the proper degree of stagnation, the greater the capillary blood-pressure, the more rapid is the infarction and the greater is its intensity. In their extensive studies on infarction, Karsner and Ash<sup>88</sup> experimentally found that hæmorrhagic infarction takes place only by slowing the circulation considerably as by the ligation of the pulmonary vein or by compressing the lungs by artificial effusion and that the greater the degree of stasis, the sooner is the true infarction likely to appear. In the Albany series, there were twelve cases of infarction among the twenty-five post-operative cases of pulmonary embolism. In nine of these twelve patients, the heart weight varied from 330 to 500 grams. In one patient, where the heart weighed 285 grams, there was quite a marked passive congestion of the lungs and abdominal viscera. In another with a heart weight of 230 grams, there were extreme congestion and œdema of the lungs. Three showed cardiosclerosis, two chronic vegetative endocarditis of the aortic valves, five chronic passive congestion of the viscera, three œdema of the lungs, three acute bronchopneumonia, one chronic fibroid phthisis, and one septicæmia. Of the remaining thirteen cases of post-operative embolism without infarction, the heart weight varied from 270 to 470 grams, of which three showed focal toxic myocarditis and two acute bronchopneumonia but no evidence of marked pulmonary circulatory stasis. Apropos of pneumonias, Hedinger and Christ<sup>66</sup> strongly stress the point that one should consider the possibility of a hæmorrhagic infarction being the underlying factor in pneumonias of the aged.

*Symptomatology of embolism*—Death from pulmonary embolism may be of dramatic suddenness. A patient sitting quietly in a wheel-chair or pleasantly conversing with other patients or relatives may suddenly fall over dead without warning. Others may show a sudden onset of extreme dyspnœa, rapidly become unconscious and expire a few minutes after the onset of symptoms. Still others may show a stormy but extremely rapid course—sudden screaming, calling loudly for air, becoming cold and clammy, and expiring immediately thereafter. In these cases of sudden death, necropsy showed complete occlusion of the main pulmonary artery or of both right and left branches. Fig. 3 illustrates very well the completely occluding type of large embolus, extending from the right ventricle into the main pulmonary artery.

Where death was delayed from several hours to ten days, the symptomatology varied from the more quiet to the violent type. In the former, the patient was somewhat restless and sleepless, followed by periods of listlessness and weakness, was very pale and perspired freely. The skin was cold and clammy. There might be vomiting of heavy thick fluid with or without nausea and passing of flatus, or expectoration of blood-tinged sputum. Towards the end, the breathing became labored. Often there was cyanosis. The pulse could not be felt and finally the breathing stopped. In

the violent type, the patients were very restless and delirious, talking very irrationally. Sometimes they became violent—screaming loudly, sitting up in bed and fighting madly. After several such attacks of violence at short intervals, they were exhausted and quiet except for twitching of the limbs. There was profuse perspiration. The eyes took on a glassy appearance. The

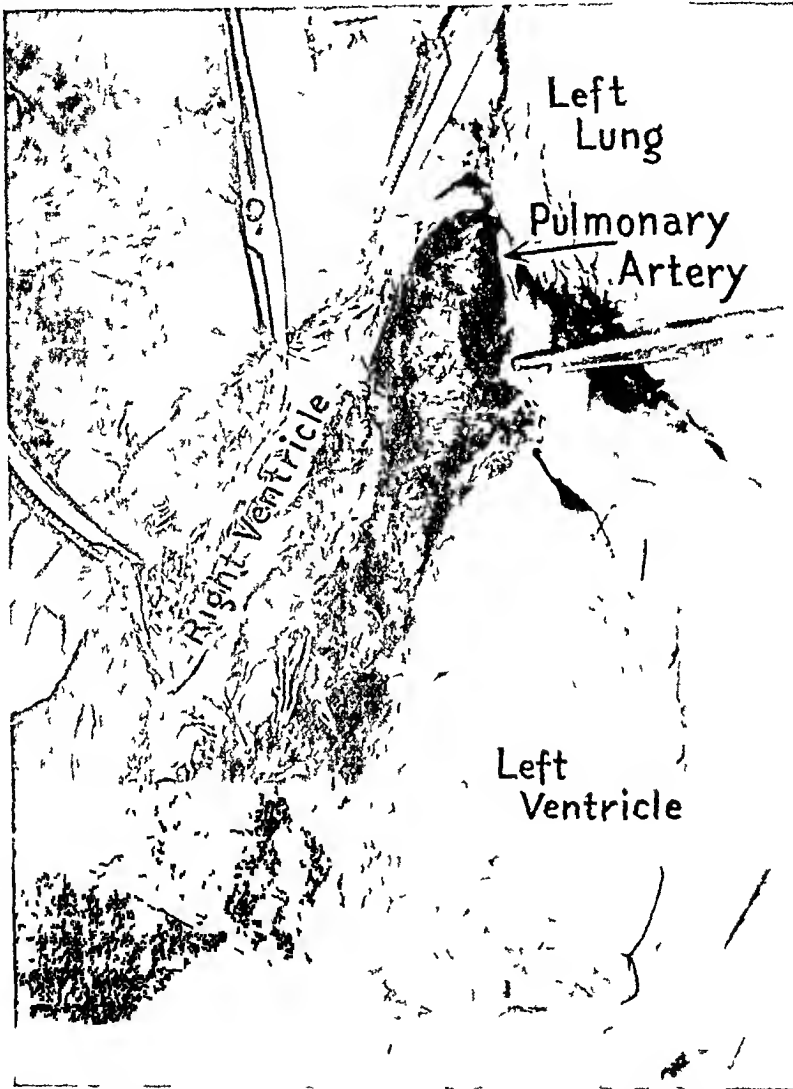


FIG 3—Photograph of heart with the right ventricle opened to show an embolus extending through the pulmonary valve into the pulmonary artery. Note that the lower end of the embolus is turned on itself, thus completely occluding the pulmonary orifice. The bend in the embolus has been partially broken, due to post mortem handling.

pulse was weak and thready, and finally could not be felt. There might be a period of unconsciousness and Cheyne-Stokes breathing preceding exitus.

The symptoms in order of their frequency were as follows: Shortness or difficulty of breathing, restlessness, cyanosis, profuse perspiration, vomiting, pains in the chest, coughing with or without blood-tinged expectoration, delirium. The pains in the chest were found in those cases where necropsy

showed infarction with or without an associated bronchopneumonia. Seven of the twelve cases of infarction did not have chest pains. Here the infarctions were smaller or more centrally located so that the pleura was not implicated. Miller,<sup>89</sup> in 1902, called attention to the significance of this post-operative pleurisy in its relation to pulmonary embolism. In one case in the Albany group where a marsupialization was done for an enormous pancreatic cyst and where the patient complained of severe chest pains, necropsy showed no pulmonary or pleural lesions but widespread fat necrosis in the abdominal cavity. Where cough was present, the lungs showed purulent bronchitis, broncho-pneumonia or diffuse pneumonitis.

The clinical history may indicate that the patient is having showers of emboli. The intervals between these showers varied from a few minutes to many days in the cases here reported. One patient had spent the last four days comfortably in a wheel-chair. One evening he suddenly became white and speechless, and perspired freely. His face was corpse-like with bulging eyes and moderately dilated pupils. He answered questions intelligently. Pulse was irregular and the heart sounds could not be heard. Face was cyanotic. There was air hunger. Wheezing and râles were heard throughout both lungs. He complained of pain over the precordium. After five minutes, the pulse became more regular and the patient began to feel more comfortable. Ten minutes later, he had another attack and died almost immediately. Necropsy showed the right pulmonary artery completely plugged. In these cases, multiple emboli both recent and old may be found scattered throughout the lungs or only one large embolus. In the latter case, the sequence of events suggests that by the force of the pulmonary stream, the different coils of the large but only partially occluding embolus are either pushed into the remaining aperture or the embolus might grow larger by secondary thrombosis.

#### EMBOLISM IN TRAUMATIC CASES

There were only three cases in which embolism occurred in traumatic cases.

CASE I—H. F., male, seventy-one years old, obese, was struck and knocked down by an automobile. There were numerous contusions and abrasions but no fractures and no cerebral injuries. After a week in bed, he was allowed up in a wheel-chair. On the eleventh day after admission, while talking and joking with other patients, he suddenly collapsed and died in a few minutes. Necropsy showed extensive hæmorrhage into the retroperitoneal tissues, cardiosclerosis with hypertrophy (heart weighed 510 grams), embolism of the main pulmonary artery, and thrombosis of varicose veins of right leg, right femoral and right iliac veins. Other findings were acute gastritis, cholelithiasis, and focal necroses of the liver.

CASE II—D. C., male, seventeen years old, accidentally shot himself while hunting, the bullet grazing his left leg and entering his abdomen. Operation consisted in brief repair of gunshot perforations of the stomach and suture of laceration of the liver. He improved satisfactorily for about a week and then rapidly began to lose ground. Empyæma of the left chest developed for which a thoracotomy was done. For two months, there was a profuse drainage from this chest. Eighteen days before death, gastric contents were detected in the empyæma discharge. He became very weak,

delirious, had much respiratory difficulty and died ninety-seven days after admission. Necropsy showed thrombosed vessels leading to a hæmorrhagic infarction of the right upper lobe of the lung, and widespread suppurative process of the left pleural cavity, left lobe of the liver, stomach, kidneys, and heart. There was in addition a localized purulent peritonitis.

CASE III—A C, male, sixty-three years old. While hurrying, he tripped over a wire, and struck his chin with considerable force as he fell. He was able to get up and walk to his office but soon developed severe generalized pain in his head, and became irrational and amnesic. Next day, he was rational but developed diplopia. Four days later, he became semicomatose. Fundus examination of the eye showed no evidence of intracranial pressure. Nine days after admission, he developed cyanosis and irregular respirations before death. Necropsy revealed fractured skull with subdural hæmorrhages, pulmonary embolism with infarction of left upper lobe, left pulmonary tuberculosis, right bronchopneumonia, obliterative endarteritis of the coronary vessels, thrombosis of coronary artery with infarction, and acute glomerular nephritis.

It may be that Cases I and III should be classified with medical embolism and Case II with post-operative embolism, but trauma may have been the contributing factor which aggravated the thrombosis or precipitated the embolism. It is to be noted that death occurred nine, eleven, and ninety-seven days after the accidents. Embolism in strictly traumatic cases was found to occur more commonly late by Strauss<sup>90</sup> and McCartney<sup>91</sup> after the usual time of occurrence of post-operative embolism. Most of McCartney's cases had fractures, only one of which was compound in type. Where the source of embolus was found, the thrombus was located at or near the site of injury. It is to be remembered that fat embolism is another very important complication of fracture that one must differentiate from embolism following thrombosis. At the Albany Hospital, there have been a number of cases of fat embolism following fractures, two of which were studied in great detail by Elting and Martin.<sup>92</sup> Moreover, fat embolism may be associated with embolism due to thrombosis. In one of the post-operative cases of embolism in the Albany series where the patient who was extremely obese had performed on her a ventral herniotomy with lipectomy, fat embolism was found associated with thrombosis and embolism as shown by the presence of fat globules in the meshes of the embolus after Scharlach R stain. For details on the diagnosis and pathology of fat embolism, the reader is referred to the excellent articles of Warthin,<sup>93</sup> and Elting and Martin.

#### MEDICAL EMBOLISM

The wide distribution of cases of medical embolism is shown in Table VI. There were twenty-one men to fifteen women, or 1.4:1. Seventy-eight per cent of the cases occurred between the ages of forty-one and seventy. There was only one child in this group—a boy of eight who had a hæmolytic staphylococcus septicæmia with multiple septic infarctions of the lungs and septic lesions of the heart, brain and leptomeninges, caused by bacterial emboli. The primary foci in this case were the sphenoidal and ethmoidal cells. Medical embolism in children appears to be quite uncommon. Smellie<sup>94</sup> believed his case of pulmonary embolism with infarction of the right lower lobe in a

TABLE VI  
*Necropsied Cases of Medical Pulmonary Embolism*

No	Sex	Age	Diagnosis	Weight of heart—gms	Source of embolus	Pulmonary infarction—lobes
1	M	41	Cardiac hypertrophy with dilatation (decompensation)		Undetermined	Right lower
2	F	42	Pyæmia, empyæmia, peritonitis	300	Pelvic veins	Multiple, septic
3	M	68	Nephrosclerosis with uræmia	750	Undetermined	Right and left lower
4	M	64	Chronic vegetative endocarditis of tricuspid, mitral and aortic valves	360	Tricuspid valves	Left lower
5	F	56	Paralysis agitans, bronchopneumonia	240	Undetermined	Right upper, septic
6	M	51	Chronic endocarditis of tricuspid and mitral valves, mural thrombus in left ventricle	740	Prostatic plexus	Multiple
7	F	42	Influenza, subacute meningo-encephalitis		Undetermined	Right lower and middle
8	M	41	Hodgkin's disease	280	Undetermined	Left lower
9	M	31	Subacute and chronic vegetative endocarditis of tricuspid, mitral and aortic valves	700	Tricuspid valves	Multiple septic
10	F	23	Streptococcic sore throat followed by bronchopneumonia and empyæmia	205	Right iliac vein and inferior vena cava	Septic, right and left lower
11	F	48	Streptococcus hæmolyticus septicæmia	415	Veins of broad ligament, left ovarian vein	Multiple septic
12	M	57	Bronchopneumonia, pleurisy with effusion	385	Undetermined	Left lower
13	F	22	Subacute and chronic vegetative endocarditis of mitral valve, streptococcus hæmolyticus septicæmia	400	Undetermined	Septic, right lower
14	F	59	Primary carcinoma of left ovary with widespread metastasis	250	Undetermined (tumor thrombus)	None
15	F	78	Aortic aneurism, mural thrombi in right ventricle	470	Right ventricle	Right lower and left upper
16	M	Old	Parkinson's disease		Undetermined	Yes
17	F	68	Bilateral ovarian carcinoma with extensive peritoneal implantation, mural thrombus in right ventricle		Right ventricle	None

TABLE VI—(Continued)

No	Sex	Age	Diagnosis	Weight of heart—gms	Source of embolus	Pulmonary infarction—lobes
18	M	8	Chronic secondary anaemia, hæmolytic staphylococcus aureus septicaemia	110	Undetermined	Multiple septic
19	M	66	Multiple abscesses of both kidneys, aneurism of right internal iliac artery	310	Undetermined	Right lower
20	M	51	Acute on chronic glomerular nephritis	430	Renal veins	None
21	M	64	Acute intracapillary glomerular nephritis	390	Undetermined	Multiple
22	M	56	Cardiac infarction left ventricle, mural thrombi in right auricle	610	Right auricle	Left lower
23	M	55	Spongiblastoma multiforme	460	Undetermined	Right and left lower
24	M	65	Cardiac infarction left ventricle, mural thrombi in right auricle	670	Right auricle	Multiple in left lower
25	M	55	Tabes dorsalis	500	Vesical veins	Right and left lower
26	M	53	Pneumococcus endocarditis of tricuspid valve with Type I septicaemia	330	Tricuspid valves	Multiple septic
27	F	34	Rheumatic pancarditis with severe decompensation, acute bronchopneumonia		Left ovarian veins	Multiple, old and recent
28	F	67	Coronary thrombosis with apical infarction	640	Undetermined	Multiple
29	F	37	Chronic rheumatic pancarditis with decompensation, subacute pericarditis, acute intracapillary glomerulonephritis	540	Right auricle	Right and left lower
30	F	65	Cardiac infarction	410	Undetermined	None
31	M	44	Syphilis (gummas of liver, etc.)	615	Undetermined	None
32	M	68	Encephalomalacia, acute bronchopneumonia	540	Undetermined	Left lower
33	F	47	Toxic adenoma of thyroid, cardiac infarction	315	Undetermined	Left lower
34	M	59	Cardiac infarction	470	Undetermined	Right upper and lower
35	F	48	Marked thrombophlebitis of varicose veins of both lower extremities	330	Left iliac vein	Left lower
36	M	65	Cardiac hypertrophy and dilatation (decompensation)	770	Undetermined	Left lower

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boy of nine years was due to the streptococcus rheumaticus, causing early endocarditis of the right aortic. One and thirty-five hundredths per cent of Gruber's and 1.83 per cent of Rupp's embolic cases occurred below ten years of age. Only four of the Albany series were definitely obese, but these individuals were forty-eight to sixty-seven years old. Age appears to be an important factor in medical as well as post-operative embolism.

It is interesting to note that fifteen (42 per cent) of the thirty-six medical cases were cardiac patients—six with cardiac infarction, four with cardiac decompensation, five with vegetative endocarditis, and two with rheumatic pancarditis. Except for three, the heart weights varied from 400 to 770 grams.



FIG 4—Photograph of lung in a very recent case of malignant endothelioma, primary in the gluteal region. Arrows point to some of the more noticeable smaller arteries plugged with tumor thrombi. To the extreme right of the photograph in the middle lobe, there is a small subpleural hemorrhagic infarct.

Eighteen or 50 per cent of the patients showed evidence of marked bacterial infection somewhere in the body.

Only six of these cases did not have infarction with the embolism. One of these was in a case of primary ovarian carcinoma with extensive peritoneal implantations and metastases. In the emboli in the pulmonary artery branches were groups of tumor cells. On the other hand, emboli may consist wholly of tumor cells. In a very recent case of malignant endothelioma primary in the gluteal region, there was a large, cauliflower-like, tumor thrombus growing beneath a leaflet of the tricuspid valve, in all lobes of the lungs, many of the



smaller branches of the pulmonary artery were occluded with tumor thrombi with only a small infarction resulting (Fig 4). A large artery to the left lower lobe was plugged with friable tumor embolus. Warren<sup>95</sup> very recently observed a chondrosarcoma of the sacro-iliac synchondrosis with extension into the large veins of the pelvis and on up into the inferior vena cava. Nineteen days before death, a considerable portion of the tumor mass in the vena cava broke away and lodged in the left pulmonary artery where it continued to grow, producing a tree-like cast of the pulmonary blood-vessels and completely occluding the pulmonary artery in the process. Welch<sup>97</sup> stated that there have been instances of sudden death from blockage of the pulmonary artery by cancerous and sarcomatous emboli. Schmidt<sup>98</sup> reported several cases of gastric carcinoma where the smaller branches of the pulmonary artery were occluded with emboli of tumor cells resulting in hypertrophy of the right ventricle. Eschbach's<sup>97</sup> most unusual case of leiomyosarcoma arising beneath the endocardium just below the pulmonary valve produced an almost occluding tumor thrombus of the pulmonary artery, complete occlusion of the left pulmonary branch and incomplete occlusion of the right with a hæmorrhagic infarction of the right lower lobe of the lung and dry pleurisy. In Shennan's<sup>98</sup> case, a spindle-cell sarcoma of the mediastinum extended through the heart into the right auricle where the growth was so large as practically to occlude the tricuspid valve opening.

In the medical cases, infarction was very common after embolism. The lower lobes were involved in 64 per cent of the cases with infarction—27 per cent in the right lower and 37 per cent in the left lower. Contrary to post-operative infarction, the medical infarction occurred more often in the left lower lobe of the lung. In 24 per cent, there were multiple infarctions all lobes being involved. The upper and middle lobes were affected only five times but an infarction was found also in one of the lower lobes.

The symptomatology of embolism with or without infarction in medical cases was essentially not different from that seen in post-operative cases. From onset of embolic symptoms to death, the duration varied from sudden to twenty-seven days. About one-third of the patients died within the first three days, two of which were sudden deaths. One of these sudden deaths occurred during the quiet of a sleep from which the patient was awakened with extreme shortness of breath, and the second, during the exertion of being helped onto a bed-pan. Very frequently, it is extremely difficult to estimate the onset of embolism in medical cases. The severity of the symptoms of heart disease or of abdominal disease may mask the pulmonary picture, or the patient may be too ill to complain of added discomforts. On the other hand, the pulmonary symptomatology may clearly indicate that the patient is having a series of embolism at various intervals. Two cases in particular showed many showers of emboli when finally the patients died fifteen and seventeen weeks later. Showers are especially liable to occur in cases of vegetative endocarditis or mural thrombosis of the right side of the heart.

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### CONCLUSIONS

(1) Sixty-four verified cases of pulmonary embolism with or without infarction form the basis of this study. They consist of twenty-five post-operative, three post-traumatic, and thirty-six medical cases of embolism. This gives a necropsy incidence for embolism of 7.9 per cent, a mortality incidence of 2.1 per cent, and a morbidity incidence of 0.102 per cent.

(2) Sex has probably no etiologic significance. The age incidence of embolic cases suddenly increases from forty years onward. Our obese patients with embolism were all in this age liability group.

(3) Embolism occurred in 0.09 per cent of the patients after general surgery and in 0.08 per cent after gynecological surgery. Sixty-four per cent of the cases occurred in the first and second weeks post-operatively. The duration of symptoms from onset of pulmonary embolism to death varied from sudden to ten days, 80 per cent dying by the third day. Sixty-eight per cent of the operations were in the lower abdomen. On the other hand, in medical embolism, the duration of symptoms were longer (as long as twenty-seven days) due to the greater frequency of smaller emboli occurring sometimes in showers. Furthermore, patients with medical embolism were not so severely affected, since only about one-third of them died within the first three days.

(4) Forty-two per cent of the post-operative emboli lodged in the lower lobes, more often on the right in the ratio of almost 2:1, 42 per cent in the main pulmonary artery or in one or both of its two branches, the right being favored. Due to the frequency of the embolism being less massive in medical cases, the emboli were able to reach the smaller branches of the pulmonary artery, in 64 per cent of the cases, the lower lobes were involved, but, contrary to post-operative infarction, medical infarction occurred more often in the left lower lobe than in the right lower.

(5) There was manifest infection in only 32 per cent of the post-operative cases, and in 50 per cent of the medical cases.

(6) Infarction after embolism is liable to occur when there is an added circulatory congestive disturbance. The heart showed a varied pathology of hypertrophy, cardiosclerosis, and endocarditis. The hearts in the medical cases were uniformly larger and 42 per cent of them showed severe lesions of hypertrophy and dilatation (decompensation), coronary thrombosis with infarction, vegetative endocarditis, and pancarditis. Infarction occurred almost twice as frequently after medical embolism as after post-operative embolism.

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## NERVE SUTURE AND MUSCLE REPAIR

### PRIMARY SUTURE OF THE ULNAR NERVE AND SECONDARY RECONSTRUCTION OF THE EXTENSOR TENDONS OF THE FOREARM

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WHEN badly lacerated wounds are treated in a well-equipped hospital immediately after a patient has been injured, frequently all the important anatomic structures can be repaired, and the patient need suffer no permanent disability. Upon admission to a hospital, an injured person, unless he is suffering from hæmorrhage or shock, can be quickly placed in a state of light anæsthesia, when the occasion requires it, for the treatment of his wound. The wound can be thoroughly cleansed of all extraneous particles, and the devitalized tissue carefully removed. An effort can be made to preserve all the tissues which have not been devitalized. Often structures which have been severed or lacerated can be repaired by suture, and the wound can be closed. Such wounds in the majority of cases heal by primary union. A wound should be drained when its surfaces cannot be approximated and when there is a likelihood of dead spaces forming that will allow the accumulation of blood or serum, which makes a fertile medium for the growth of the bacteria with which the wound was contaminated. If it is considered necessary to drain the wound, adequate drainage should be established to facilitate the rapid escape of blood and serum from the depths of the wound. Badly contaminated wounds are usually better left open and an antiseptic treatment carried out. When a primary closure of a wound is feasible, the wound should be thoroughly swabbed with an antiseptic solution. Whether the wound is closed by primary suture, secondary suture, or allowed to remain open, the patient should be given a prophylactic dose of tetanus and gas gangrene antitoxin.

The following case illustrates the results which may be obtained when the treatment of badly lacerated wounds is carried out under favorable conditions.

CASE No 1325—V E M, aged fourteen years, was brought into Casualty Hospital, Washington, D C, August 22, 1922, immediately following an injury which occurred on a farm about ten miles from the city. The injury resulted in multiple lacerations of both arms and both legs. The boy had been driving a double team of horses hitched to a mowing machine. As he stood on the machine and leaned forward to adjust part of the harness, the horses became frightened and ran away. The machine suddenly lurched forward, and the boy lost his balance, fell forward, and dropped on the ground in front of the mower. As the machine passed over him the blades made several deep lacerations in his arms and legs.

When the patient was admitted to the hospital it was found that the shock and the loss of blood were not great enough to contra-indicate the immediate treatment of his



wounds. A state of light anæsthesia was produced by nitrous oxide, oxygen, and ether, and the wounds were treated.

The lacerations which had produced the most serious damage were those in the right upper extremity. On the posterior aspect of the right arm about two inches above the olecranon there was a deep laceration which had divided all of the tissues of the arm down to the humerus. When this laceration was explored it was found that the triceps had been partially severed, the ulnar nerve divided, and a groove furrowed in the

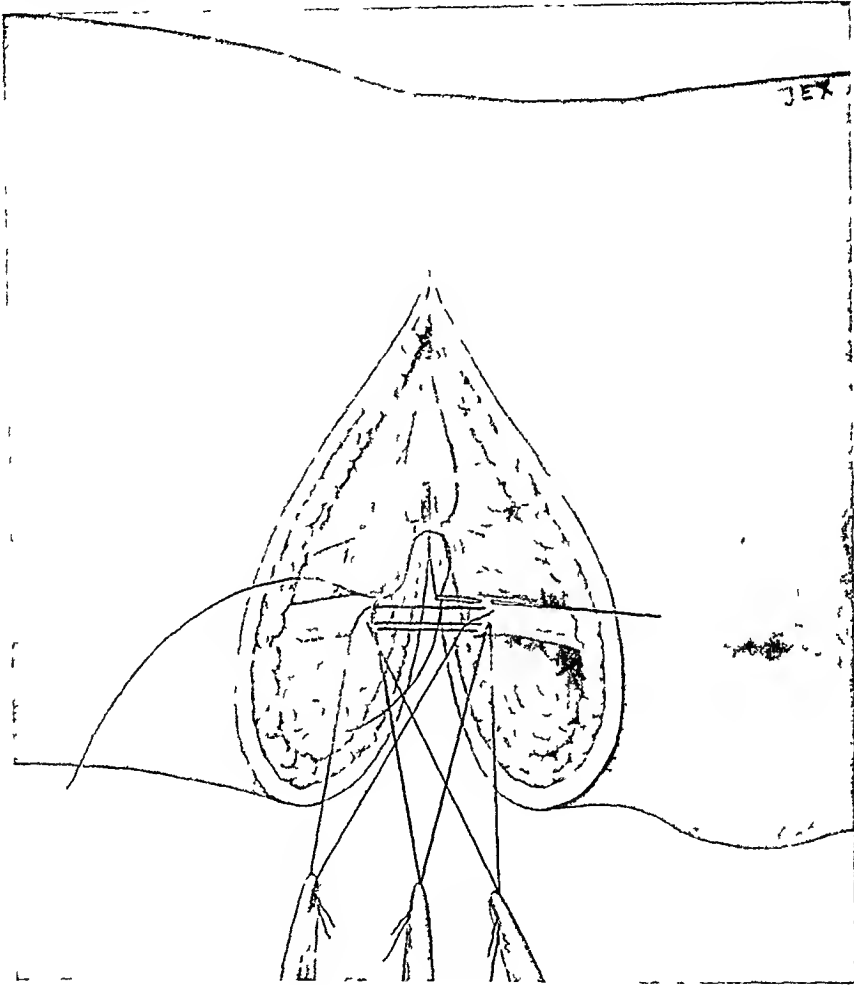


FIG. 1.—The end to end anastomosis of the ulnar nerve showing the cut ends of the nerve and the method of placing the fine silk sutures in the sheath of the nerve. The laceration of the triceps and the groove that was cut in the posterior surface of the humerus are also shown.

humerus. This wound was bathed with ether, the devitalized tissues were excised, a 5 per cent solution of picric acid was applied to the wound surfaces, and the tissues were approximated. The triceps was sutured by approximating the muscle fibres with plain catgut sutures, and the fascial sheath with interrupted chromic catgut sutures. The ends of the ulnar nerve had retracted. Both the distal and proximal ends were found. Each end was then cut squarely across, and these freshened ends were anastomosed with interrupted sutures of fine silk placed in the sheath of the nerve (Fig. 1). The skin was closed with silkworm sutures and silk. In the middle of the forearm there were two deeply lacerated incisions which had severed the superficial group of the extensor muscles in two places. These two wounds were washed with ether, and the devitalized skin, subcutaneous fat and muscle were excised. The debridement required the removal of the

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superficial group of extensor muscles which lay loosely between the two lacerations. Picric acid in 5 per cent solution was applied to the wound surfaces, and the wound was closed without drainage. Because of the number of lacerations and the time it required to treat them and to anastomose the ulnar nerve, it was thought not advisable to attempt a primary reconstruction of the extensor muscles of the forearm. The reconstruction of these muscles was therefore deferred. To immobilize the arm following the anastomosis of the ulnar nerve and the suturing of the triceps muscle, the arm, the forearm, and the

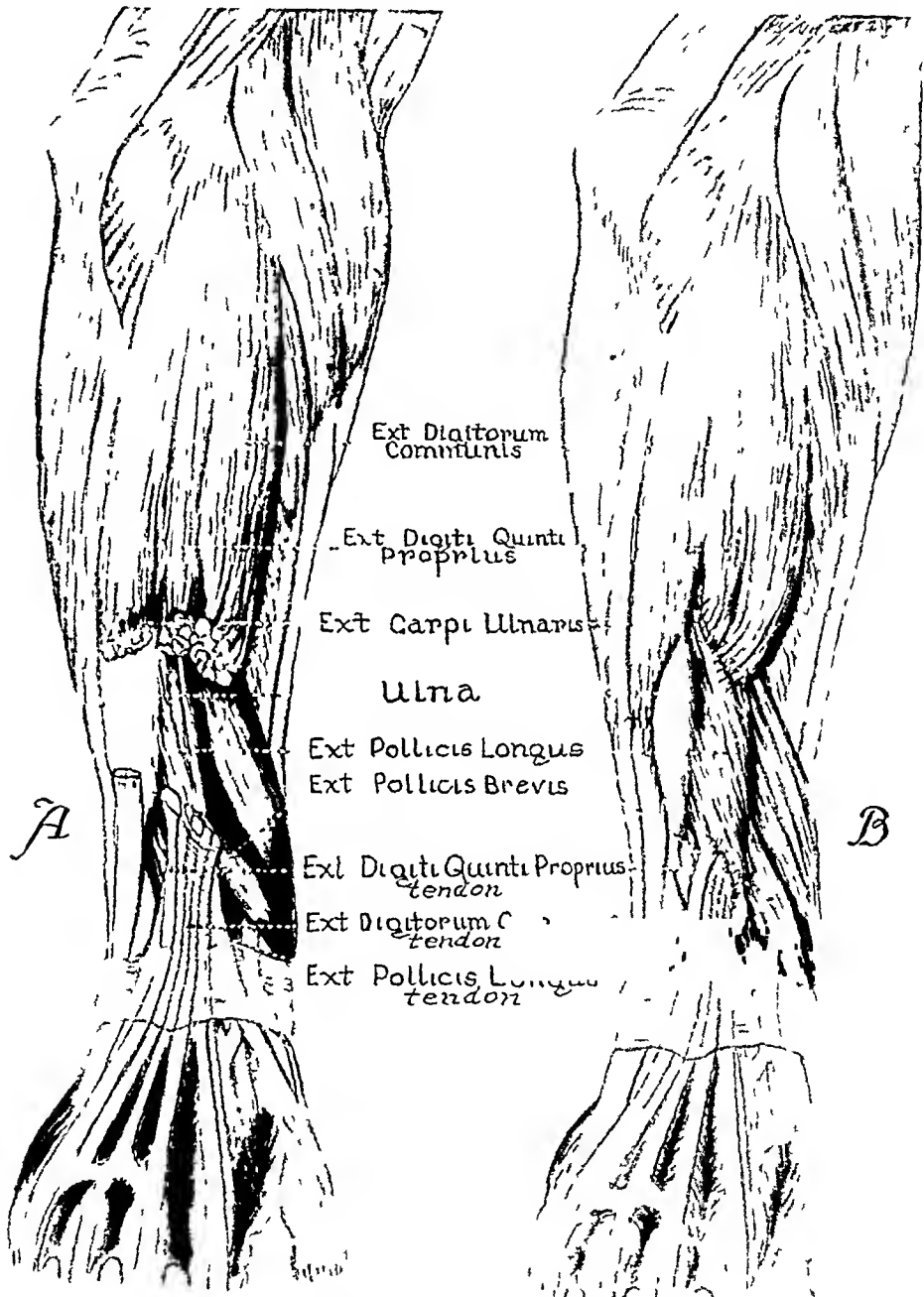


FIG 2—A—Showing the defect in the superficial extensor muscles resulting from the excision of devitalized muscle caused by a contused laceration. B—Showing the method employed to reconstruct the extensor muscles of the forearm.

hand were placed in a plaster cast. The wounds of the left forearm and the right and left thighs were bathed with ether, the devitalized tissues were removed, and the wounds were swabbed with 5 per cent picric-acid solution and closed without drainage. A prophylactic injection of tetanus antitoxin was administered. All of the wounds healed by primary union. The patient was dismissed from the hospital September 1, 1922, and

he was instructed to return in about one month for a reconstruction of the tendons of the right forearm

The patient was re-admitted to the hospital October 4, 1922. The following morning a reconstructive operation was performed. Through a long incision on the dorsal aspect of the right forearm the retracted ends of the divided extensor digitorum communis, extensor digiti quinti proprius, and extensor carpi ulnaris were found to be firmly held in scar tissue. The ends were dissected free from the scar tissue, and the reconstructive operation was planned. The proximal ends of the extensor digitorum communis and the extensor digiti quinti proprius were fastened into the belly of the extensor pollicis longus. The tendon of the extensor pollicis longus was divided about one inch above the wrist, and into it were sutured the tendons of the extensor digitorum communis and extensor digiti quinti proprius. The distal end of the extensor pollicis longus was sutured into the side of the extensor indicis proprius. The ends of the extensor carpi ulnaris were approximated by lengthening the tendon of the distal segment and suturing it to the end of the proximal segment (Fig 2). Chromic catgut



FIG 3—Photographs of the patient's right forearm and hand showing the degree to which the patient can extend and flex the fingers

sutures were used in the tendons. The wound was closed without drainage, and a splint was applied to the forearm. The wound healed by primary union.

The patient was kept under close observation so that I could note the return of the function of the ulnar nerve and of the extensor muscles of the right forearm. About one month after the reconstructive operation on the extensor muscles the use of the splint was wholly discontinued, and the patient was allowed to begin active movements. Both active and passive movements were gradually increased, and the function of the forearm and hand returned rapidly. Complete sensation came back slowly. Six months after the end-to-end anastomosis of the ulnar nerve, the patient had good sensation to cotton-wool and pin pricks over the ulnar side of the hand, the outer half of the middle finger and the fourth and fifth fingers. Shortly after the return of sensation the patient started to play ball and continued to play it all spring and summer. A year and a half after his injury he played an entire season on a high-school baseball team. After leaving school he learned carpentry and has since worked at this trade. On April 13, 1931, I examined the patient and found that with the exception of a loss of sensation in the tip

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of the little finger and an inability to completely extend the fourth and fifth fingers, the function of his right hand is entirely normal (Fig 3) He now has a useful and almost completely normal hand

DISCUSSION—*Suture of the Ulnar Nerve*—A favorable prognosis for the return of motor and sensory function following the suture of peripheral nerves depends largely upon whether the anastomosis is made soon after the injury Most of the large series of cases of nerve suture which have been published comprise cases treated during the War and include cases of both primary and secondary suture or of secondary suture only On the basis of several series of secondary suture, Thorburn<sup>1</sup> estimated that good results followed secondary suture in “somewhere between one-third and two-thirds of all cases” His personal experience was that in a secondary suture “a perfect neurologic recovery is rarely, if ever, obtained” Tinel,<sup>2</sup> in 1917, expressed a more optimistic view “At the present time,” he said, “basing our opinion on a very large number of observations made since the beginning of the War, we are justified in affirming that the prognosis of peripheral-nerve lesions is, on the whole, favorable Every peripheral nerve affected by traumatism tends to regenerate, provided the general condition of the patient enables him to contribute towards this restoration” Tinel<sup>2</sup> investigated the results following nerve suture or grafting in 108 cases, some of which were operated upon under favorable, others under unfavorable, conditions He found that in 22 cases there was an almost complete return of function, in 72 cases there was more or less rapid progress being made towards a restoration of function, and in only 14 cases was there no sign of regeneration “Early intervention,” Tinel said, “does not appear to be an indispensable condition Nevertheless, there can be no doubt but that early sutures are followed by more rapid regeneration” Delagenière,<sup>3</sup> who had 245 cases of nerve suture under observation for two and a half years following anastomosis, reached a conclusion somewhat similar to Tinel’s “The earlier the nerve suture is performed,” Delagenière stated, “the more rapid is the regeneration” Before the War he had made a number of nerve anastomoses immediately following injury, and in every case the anastomosis resulted in a functional cure

When a nerve is sutured soon after its injury there is a minimum of resection necessary as the nerve has not become invaginated by progressive sclerosis, there is also a maximum of mobility and elasticity of the nerve, which facilitates a good approximation of the nerve ends Immediate suture may save the patient months of treatment and delay in cure if the intervention is successful, if it is not successful, it has not endangered the ultimate result

The prognosis for the ulnar nerve is less favorable than for other peripheral nerves Thorburn,<sup>1</sup> when discussing the results obtained at the Grangethorpe Military Hospital, in Manchester, said “The ulnar nerve is particularly disappointing and the recovery of voluntary power in the small intrinsic muscles of the hand was exceedingly poor” Platt and Bristow<sup>4</sup>

expressed a similar opinion. A good return of function following the immediate suture of the ulnar nerve has been reported in a few instances. Rawlence,<sup>5</sup> in 1920, reported a case of a soldier who was wounded in the elbow-joint by an exploding shell. Four hours later the wound was cleansed, the devitalized tissues were excised, and the ends of the ulnar nerve "were brought together by a holding suture." An interrupted elbow splint was applied. Five days later the entire surfaces were cleansed, and the elbow-joint was sutured. The ends of the ulnar nerve which had been brought together were found in apposition. The silk holding-suture was removed and a flap of muscle from the internal condyle was brought over the nerve anastomosis. The arm was put in a splint in extension. Fifteen days later passive movements were started. After two more weeks the movements of the intrinsic muscles of the hand were good, although still weak. Two cases in which excellent results followed the suture of the ulnar nerve were reported by Lacroix,<sup>6</sup> in 1923. A boy, ten years of age, cut his right wrist, completely severing the ulnar and median nerves and the palmaris longus, the flexor carpi radialis, and the flexor digitorum sublimis tendons. Half an hour later the severed ends of the ulnar and median nerves were sutured end-to-end through the nerve sheath with interrupted stitches of No. 00 chromicized catgut. The tendons were sutured with silk. A dorsal splint was applied. Three weeks later resistive exercises were begun. Five weeks after the anastomoses were made, the gripping power and sensation were normal. Equally good results were reported by the same author in the case of a girl, nine years of age, who had the ulnar and median nerves and the palmaris longus, the flexor carpi radialis, the flexor carpi ulnaris, and the flexor digitorum sublimis tendons of the right wrist accidentally severed. The author used the same method of suture as he did in the preceding case. He reported that three and a half months after the injury the hand and fingers were normal. Bunnell<sup>7</sup> recorded two cases of a return of the sensory function following a suture of the ulnar nerve made some months after the injury in which it was severed. In one case all the nerves and tendons in the front of the wrist were destroyed by an infection which developed after the wrist had been cut. At operation, five months after the injury, the ends of the ulnar nerve were found to be an inch apart, and the ends of the median nerve three inches apart. The nerve ends were anastomosed by direct union, and the tendons indirectly by means of grafts. A little less than a year later all the fingers were sensitive to pin pricks and cotton-wool. In the other case reported by Bunnell the ulnar nerve was severed at the wrist. Twenty-one months later the nerve ends were sutured. Three and a half months after the anastomosis sensation was normal in the hand and fingers.

*Suture of the Extensor Tendons of the Forearm*—The primary suture of tendons is a difficult and arduous procedure. But, as Lemaitre<sup>8</sup> pointed out, it gives results directly proportional to the care taken in examining the injured tissues, in excising all such devitalized tissues as might serve as culture media, in extracting all minute foreign bodies and fragments of

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bone, in excising sparingly the skin, connective tissue, fascia, and muscles which might form "chambers of attrition", and in practising scrupulous hemostasis and asepsis

Not every injured person can be subjected to the tedious procedure of a reconstructive operation and primary suture. Certain conditions may exist which will necessitate deferring the reconstructive measure or delaying the closure of the wound. The wound may be contaminated or infected, it may contain a zone of lymphœdema or of lymphangitis, or gas gangrene may be present. It may be impossible to explore the entire wound or to extract all the minute extraneous fragments. Reconstructive measures may have to be deferred on account of the great number of wounds requiring treatment. If the patient is suffering from shock, hæmorrhage, fever, or alcoholism, primary suture may be inadvisable, depending upon the degree of the condition.

Good results following a secondary reconstruction of the extensor tendons of the arm and hand have been reported. Such a case was reported by Bradburn,<sup>9</sup> in 1922. The extensor digitorum communis and the extensor pollicis longus had been severed when the patient ran his hand through a window pane. The tendons were sutured by another surgeon. The patient developed an inability to extend his middle and ring fingers and the terminal phalanx of his thumb. When Bradburn operated three months after the injury he found that two and a half or three inches separated the proximal end of the extensor digitorum communis from the tendons of the ring and middle fingers. With a continuous suture of No. 9 silk thread, new tendons were made of four strands of the suture connecting the tendons of the middle finger, the ring finger, and the thumb to the severed end of the extensor digitorum communis. Each silk cable was surrounded by a tube of fascia lata which was sutured to the tendon ends. The hand became normal in function, the new extensor longus pollicis moving independently of the middle and ring-finger tendons. A case was reported by Merrill<sup>10</sup> in which a soldier who was wounded on the dorsal surface of the left forearm could not extend his fingers and thumb after the débridement, suppuration, and healing of his wound. At operation, six months after the wound had healed, the stumps of the extensor tendons were found to be irregularly severed. A reconstructive operation on the extensor tendons was then carried out. After a period in which the hand was kept in a splint and a second period in which it was given exercise, the patient could extend his fingers and thumb normally and could move his index finger independently of the other three. In a case reported by Bunnell,<sup>11</sup> the extensor tendons of the index and middle fingers and the extensor carpi radialis brevis had been severed. Infection developed, resulting in scar tissue which bound all the dorsal tendons. Two months after the injury these tendons were dissected from the enveloping scar tissue. The severed ends of the extensor carpi radialis brevis were sutured directly. The divided ends of the extensor tendons of the index and long fingers were anastomosed indirectly by means of grafts taken from the

palmaris longus Four months later there was a considerably improved but not wholly normal function of the sutured tendons Bunnell<sup>11</sup> also reconstructed an extensor pollicis longus tendon three months after it had been accidentally severed He used a graft of two and a half inches taken from the palmaris longus to bridge a gap between the divided ends of the tendon Three months after the reconstructive operation the patient had an almost normal use of his thumb Kanavel<sup>12</sup> mentions a case in which a destroyed portion of an extensor pollicis longus was replaced by strands of silk covered with a transplant of fat Normal function of the thumb was restored

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# ANTIVIRUS TREATMENT OF MALIGNANT ŒDEMA INFECTIONS

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INFECTIONS of the human body caused by the bacillus of malignant œdema are so seldom met with these days that it seems advisable to report the following case, the more so because of the methods used in treating it and the results obtained

The clostridium of malignant œdema, also called bacillus of malignant œdema—Koch or *Vibrio Septique*—Pasteur, is a large rod-shaped organism with rounded ends. Young bacilli retain the Gram stain—older ones do not. They are motile and possess many flagella. Endospores are formed, mostly centrally situated, sometimes at the end. The bacillus does not produce any proteolytic enzymes. It decomposes starch and carbohydrates, forming butyric acid, carbon dioxide, hydrogen sulphide and methane. The organisms are found frequently in the soil, hay dust and in the intestinal tract of the herbivora.

Simple inoculation of an abraded surface will not, as a rule, produce infection in either animal or man, because the presence of oxygen is detrimental to its growth, but when the bacillus is introduced into a wound and oxygen excluded, infection occurs.

The bacilli in the subcutaneous tissues produce marked œdema, with the formation of gases, which have an obnoxious odor. The muscles are rapidly destroyed by the organisms, but the tendons, nerves, cartilage and osseous structures do not seem to be affected. In fatal cases the organisms get into the blood-stream and attack the viscera.

REPORT OF CASE—Leonard M., aged twelve years, white, fell from a tree, a distance of thirty-two feet, September 13, 1930, at 7 30 A M. About an hour later he was seen by Doctor Merten who had him taken to the Milwaukee Hospital. When admitted the boy appeared to be in great pain, the face was pale, temperature, 99.2° Fahrenheit, pulse, 80, respiration, 20. The radius of the right arm was protruding two and one-half inches. Fifteen hundred units of antitetanic serum were given. At 9 30 A M the boy was placed on the operating table, put under ether anæsthesia, the wound was enlarged and it was found that there was also a fracture of the ulna, one-half inch from the joint, and that the radius had separated from its epiphysis. Fragments of dried leaves and grass were cleaned out of the wound. The wound was then washed out three times with ether, the bones put in apposition, a gutta-percha drain inserted, and the wound was closed. A splint was applied and the boy was sent back to bed. On the next day the temperature rose to 103°F and the pulse to 100, the temperature declining to 102°F by four o'clock in the afternoon. On the third day the arm was swollen up to the axilla, and an offensive odor was noticed. However, no crepitus could be elicited. Smears and cultures were taken from the wound by Doctor Oesterlin, who reported



that the smears showed the presence of a large bacillus which did not take the Gram stain

The wound was then laid wide open and tubes were inserted for the continuous irrigation with Dakin's solution. The temperature dropped to  $99.5^{\circ}\text{F}$ , but the pulse remained around 100. No change was noted in the swelling of the arm.

On the eighth post-operative day, the report of a definite infection with the bacillus of malignant oedema was received from the laboratory. Because there was no vaccine or serum against bacillus of malignant oedema available, patient was given 10 cubic centimetres of polyvalent perfringens serum, this was followed by a chill and a rise in temperature, the next morning the temperature had dropped to  $99.6^{\circ}\text{F}$ . That day patient was given another 10 cubic centimetres of perfringens serum, no chill followed but the temperature rose to  $101.2^{\circ}\text{F}$ , but on the following morning dropped to  $98.6^{\circ}\text{F}$ , the pulse, however, remained around 110.

The swelling of the arm not having receded much, the next day the boy was given



FIG 1

FIG 1—Lungs and liver of guinea pig immunized by intraleural injections of malignant oedema antiviral. Pleura smooth and shiny, positively no exudate. Liver shows no pathologic lesions.



FIG 2

FIG 2—Shows lungs of two control animals. They are covered by thick masses of fibrino-purulent exudate. Liver shows intense fatty degeneration.

20 cubic centimetres of perfringens serum. No chill followed, the temperature rose to  $102^{\circ}\text{F}$ , but by the following morning had dropped to  $100^{\circ}\text{F}$ , where it remained for about five days.

The swelling of the arm had receded somewhat and crepitation could now be elicited. We were unable to determine the presence of air bubbles by means of X-ray examination.

The temperature reached normal on the fifteenth post-operative day, and after that it fluctuated between  $98.6^{\circ}\text{F}$  and  $100^{\circ}\text{F}$ , with the pulse between 100 and 120. Cultures taken at different times still showed the presence of the bacillus of malignant oedema. Four weeks after the injury, the arm was still swollen, and gas bubbles were still coming out of the wound.

On the twenty-eighth post-operative day, the Dakin's solution was discontinued,

and an antiviral (prepared by Doctor Oesterlin), was used as a dressing. The preparation of this antiviral will be described later. Within two hours after the antiviral had been applied to the wound, the temperature rose to  $101.4^{\circ}\text{F}$  followed by a drop to normal within forty-eight hours. For the first ten days the wound was dressed every twelve hours with the antiviral preparation. At the end of thirty-six hours after the application of the antiviral, the swelling of the arm rapidly receded and after the third day had disappeared entirely. The wound itself now began to look cleaner and the amount of gas emanating from the wound was lessened. On the eighth day after the beginning of the antiviral treatment, the wound showed definite signs of healing and no gas could be found. The temperature fluctuated between  $98.6^{\circ}\text{F}$ , until the thirty-seventh post-operative day, when it remained normal until the patient's discharge from the hospital October 31, 1930. While the anatomic result in this case is not all that could be desired, the boy has a functional hand, and not an artificial appliance. At no time during the stay in the hospital did cultures or smears reveal any other organisms but the bacillus of malignant œdema.

*Experiences with Filtrates of Bacillus Œdematis Maligni*—In our case no satisfactory success with the polyvalent serum could be obtained, and therefore Doctor Oesterlin tried to prepare an antiviral and to determine what effect this treatment might have in animals.

Already, in 1924, Besredka incubated broth cultures of staphylococci and streptococci for eight days at  $37^{\circ}\text{C}$ , then filtered them through Chamberland candles. He obtained atoxic filtrates which he called "Antiviral." It contains products of metabolism of the bacteria which act upon tissues producing a local immunity of the receptive cells in such a way that the cells are not sensitive any more to the virus and therefore the tissues become resistant to further infection.

Besredka performed the immunization intracutaneously, either by injection or by application of wet dressings with antiviral. He found the antiviral strictly specific, that means a previous treatment with staphylococcus antiviral only protected against a staphylococcus infection and not against streptococcus infection and *vice versa*.

The antiviral cannot be compared with any immune bodies like antitoxins, agglutinins, amboceptors, *etc*, because of its thermo resistance. It can withstand a temperature of  $100^{\circ}\text{C}$  for ten minutes.

In 1929, Doctor Oesterlin had demonstrated the action of antiviral in the pleural cavity. He injected filtrates of eight-day-old pyocyaneus cultures into the pleural cavity of rabbits and guinea-pigs and could immunize them against fatal doses of bacillus pyocyaneus. If he injected another antiviral or plain broth instead of pyocyaneus antiviral, the animals died the same as the controls which had not been treated previously.

Obtaining a strain of malignant œdema from our patient, we tried first to protect white rats by intrapleural injections of specific antiviral against malignant œdema infection. The antiviral was prepared in the following way. We made a broth culture of bacillus of malignant œdema in a flask, overlaying it with liquid paraffin and left it in the incubator for eight days, then we filtered the culture through a Berkefeld filter. We heated the filtrate five minutes to  $100^{\circ}\text{C}$ . Using this filtrate immediately, we had the same

effect as when we planted the filtrate once more with bacillus of malignant œdema, incubated it for eight days more and filtrated it a second time, therefore we used mostly "first filtrates" The antivirus proved to be perfectly innocuous

The following is one of the many experiments which demonstrate the effect of the antivirus We injected 2 cubic centimetres of malignant œdema antivirus into two rats intrapleurally and repeated the injection after three days At the same time we treated one rat in the same way, using, instead of antivirus, plain broth Five days later these three animals, and two new ones as control animals, were given 1 cubic centimetre of anaerobic broth culture of malignant œdema intrapleurally The animal treated with plain broth and the two untreated animals died within twenty-four hours They showed a severe pleurisy, both pleuræ being covered by fibrinopurulent exudate and the pleural cavity filled with 3 cubic centimetres of serohæmorrhagic fluid, there was also a fibrinopurulent pericarditis present

The two animals treated with antivirus continued to be in perfect health One of these animals was killed at the end of eight days and the other one after two weeks They showed positively no lesions The pleura proved to be free and perfectly clear and shiny, no exudate in the pleural cavity No pneumonia

In another set of experiments we tried to find out whether the action of antivirus is a specific one or not We injected malignant œdema antivirus intrapleurally into two animals, bacterium coli antivirus into the third animal The injections were repeated after three days Two untreated animals were taken as controls Then we injected 1 cubic centimetre of anaerobic broth culture of malignant œdema into all five animals The animal treated with bacterium coli antivirus died at the same time as the control animals—twenty-four hours after injection, while the animals treated with malignant œdema antivirus were perfectly well after injection After one week one animal was killed, the other animal after two weeks The autopsy did not reveal any pathologic lesions in the thoracic cavity

The results were similar after intracutaneous injection of antivirus We made experiments in guinea-pigs and white rats We injected twice intracutaneously 5 cubic centimetres of malignant œdema antivirus As control we again used animals injected with the same amount of coli antivirus and untreated animals All these control animals died within twenty-four hours They showed the typical picture of malignant œdema the skin was discolored greenish-black, the abdominal wall very œdematous, the muscle was very brittle and peeled readily from the skin

The immunized animals were, however, not without lesions

The effect of the injection was not a diffuse phlegmon, but a circumscribed infiltration of variable size, later on an ulcer developed which healed in thirty to forty days In one case the subcutaneous injection in the centre of the abdominal wall produced no lesions at the site of injection, but an œdematous phlegmon of the skin of the thorax developed The animal recovered

It seems paradoxical that we were not able to obtain any results in animals with wet dressings with antivirus regardless whether we applied them before or after injection All the animals died at the same time as the control animals

#### SUMMARY

- (1) A case of malignant œdema infection has been reported
- (2) Most of these cases require amputation to save life
- (3) The antivirus was the factor in saving the hand of this patient
- (4) Experiments in guinea-pigs and white rats showed a specific action

of malignant œdema antivirus previous to infection with the corresponding germ

(a) When we applied the antivirus *intrapleurally*, no lesions occurred in the previously treated animals, while all the control animals died as well as the animals previously treated with *another* antivirus

(b) Subcutaneous prophylactic treatment protected the animals against death, while the control animals as well as animals treated with a different antivirus died between twenty-four hours. Infection, however, *took place* in form of localized infiltrations which exulcerated and healed in about a month

(5) Wet dressings with filtrate were of no avail in animals

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# CLOSING THE BRONCHIAL STUMP IN PULMONARY SURGERY\*

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PERMANENT closure of the bronchial stump in performing a lobectomy is one of the factors of greatest importance. Failure to obtain a permanent air-tight stump is by far the greatest single factor responsible for the high mortality of this operation. Experimental studies have been reported elsewhere<sup>1</sup> which adequately explain the reason for lack of healing of the bronchial stump in a high percentage of cases. The experiments reported at this time describe a method in its various stages for the permanent closure of large bronchi.

*Experimental*—Dogs were used exclusively. A pre-bronchoscopic dose of morphine gram 0.015 and atropine gram 0.0004 per kilogram of body weight was given about one and one-half to two hours before bronchoscopy. Five, 15, 35, 50 and 75 per cent solutions of silver nitrate were used.

*Procedure*—At the time of bronchoscopy the dog was in a semi-conscious condition and offered little resistance to the procedure. A small amount of mask ether readily quieted the few that were active. A small pledget of cotton attached to a wire rod was saturated with the silver nitrate solution and introduced into a bronchus through a bronchoscope. It was allowed to remain for ten seconds and on removal a whitish eschar remained, the density of which depended upon the strength of the solution employed. The experiments were divided into four groups, the first group being sacrificed at the end of one day, the second at the end of one week, the third at the end of two weeks and the fourth at the end of one month.

As in the earlier experiments, the dogs were quiet, would not eat and appeared somewhat ill for the first two to four days post-operatively. After the first two or three days, a non-productive cough was noted which usually lasted from several days (four to five) to two or three weeks depending upon the percentage of the solution of silver nitrate used. After the first week they became quite active and appeared entirely normal except for exhibiting a non-productive cough.

With the expiration of the experiments, the animals were sacrificed and gross and microscopic studies made.

*RESULTS—Group I (one day)*—(a) Five per cent silver nitrate—one day. At autopsy the lung lobe presented a bluish-red discoloration and induration on the surface opposite the site of injury. The bronchial mucosa was swollen and ulcerated.

Microscopic examination showed necrosis of the bronchial epithelium with some degenerative changes in the musculature. The bronchial wall and surrounding parenchyma exhibited marked oedema with scattered blood pigment in the latter. There was marked infiltration with polymorphonuclear leucocytes and to a much less extent with round cells. (Fig. 1.)

(b) Fifteen per cent silver nitrate—one day. The lung surface presented the same findings of discoloration and induration as seen in Ia. The bronchial mucosa was swollen, hæmorrhagic and ulcerated.

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On microscopic examination both bronchial epithelium and musculature were found necrotic. The cartilages and elastic tissue were also partially destroyed. The bronchial lumen contained a purulent exudate. The parenchyma adjacent to the bronchus was oedematous and heavily infiltrated with polymorphonuclears and to a less degree with lymphocytes. The alveolar spaces were entirely obliterated. Scattered blood pigment was much in evidence.

(c) Thirty-five per cent silver nitrate—one day. Grossly the lung surface appeared very much as in *1a* and *1b* except that more tissue was involved. The bronchial mucosa was oedematous and ulcerated, almost completely obliterating the bronchial lumen.

Microscopic examination showed all elements of the bronchial wall to be totally necrotic, with the exception of the cartilages which were only partially destroyed. Much oedema and some hæmorrhage were seen in the surrounding parenchyma with



FIG 1



FIG 2

FIG 1—Microscopic appearance of bronchial wall and surrounding parenchyma one day following cauterization with a 5 per cent solution of silver nitrate. A—Bronchial lumen. B—Infiltrated bronchial mucosa. C—Cartilages little damaged. D—Infiltrated surrounding parenchyma. ( $\times 25$ )

FIG 2—Microscopic appearance of bronchial wall and surrounding parenchyma one day following cauterization with a 35 per cent solution of silver nitrate. A—Necrotic bronchial wall. B—Surrounding parenchyma heavily infiltrated. ( $\times 25$ )

marked infiltration of neutrophilic leucocytes and round cells. Scattered blood pigment was also much in evidence. (Fig 2)

(d) Fifty per cent silver nitrate—one day. The surface of the lung showed much discoloration and induration as described above. The bronchial mucosa was necrotic and the surrounding parenchyma heavily injected.

Examination under the microscope revealed complete necrosis of the entire bronchial wall. The bronchial lumen contained a purulent exudate. The infiltrating process in the surrounding parenchyma was more extensive than seen heretofore. Polymorphonuclear leucocytes and round cells were about equal in number. Much more blood pigment was in evidence with frank hæmorrhage in many places. A few wandering cells filled with blood pigment were present (macrophages). (Fig 3)

(e) Seventy-five per cent silver nitrate—one day The lung surface at the apex of the lobe exhibited a very extensive bluish-red discoloration and induration. An eschar was present at the site of the injury, with much injection of the surrounding parenchyma.

Microscopic examination revealed the bronchial wall and also several millimetres of the surrounding lung parenchyma to be entirely necrotic. The microscopic picture otherwise was very similar to that seen in the 50 per cent one-day section except that the process was more extensive.

*Group II (one week)*—(a) Five per cent silver nitrate—one week The surface of the lung lobe appeared grossly normal, however, the bronchus at the site of injury revealed considerable scarring with about 50 per cent stenosis of its lumen at that point.

Microscopic examination showed the bronchial epithelium partially regenerated. Beneath it were signs of organization evidenced by many small capillaries with forma-



FIG 3

FIG 3—Microscopic appearance of bronchial wall and surrounding parenchyma one day following cauterization with a 50 per cent solution of silver nitrate. A—Necrotic bronchial wall. B—Surrounding lung parenchyma heavily infiltrated. ( $\times 25$ )



FIG 4

FIG 4—Photomicrograph one week following cauterization of bronchus with a 5 per cent solution of silver nitrate. A—Regenerating bronchial epithelium. B—Connective tissue formation. ( $\times 75$ )

tion of reticular and fibrillar connective tissue. A considerable amount of blood pigment was present in the reticulum with also a varying amount of granular material. A small number of lymphocytes were still present and fibroblasts were seen everywhere (Fig 4).

(b) Fifteen per cent silver nitrate—one week The lung lobe was found 100 per cent atelectatic accompanied by complete stenosis of its primary bronchus.

Microscopic sections revealed partial regeneration of only the bronchial epithelium. A marked round-cell infiltration was still present with many fibroblasts scattered throughout. Very few polymorphonuclear leucocytes were seen. A fair number of plasma-cells had made their appearance. Much evidence of reorganization was seen in the numerous capillaries in the mucosa. Fibrillar connective tissue was present in parts

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with scattered blood pigment. The cartilages were extensively damaged, being twisted and misplaced in their relationship. Complete stenosis was accomplished by much fibrillar connective tissue, through which were dispersed the damaged cartilages and lymphocytes. The entire parenchyma was atelectatic, the alveolar walls being in close apposition. The elastic tissue of the bronchus was entirely destroyed (Figs 5, 6, and 7).

(c) Thirty-five per cent silver nitrate—one week. The surface of the lung lobe presented a bluish-red discoloration with moderate induration. The site of injury was located at the division of the primary bronchus into two secondary bronchi. One secondary bronchus was completely stenosed, the other only 50 per cent stenosed. There was no atelectasis.

Microscopic studies showed much epithelial regeneration. The elastic tissue and bronchial musculature were entirely destroyed. The cartilages were also almost entirely

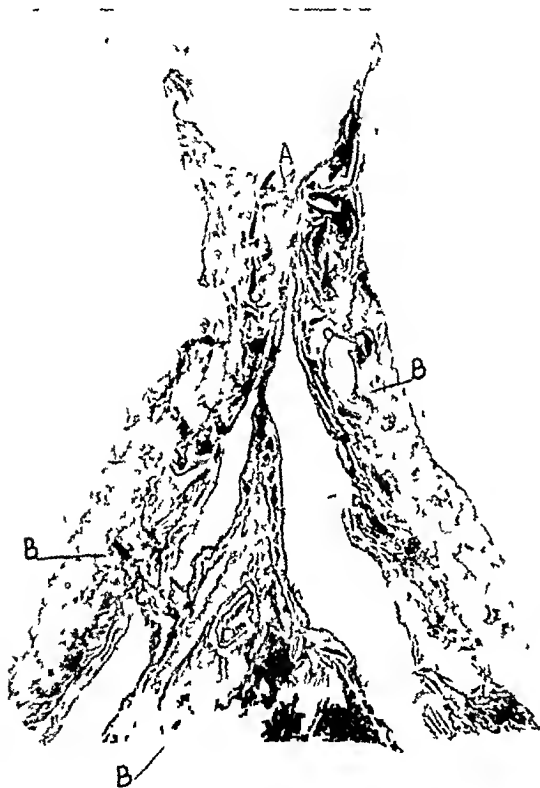


FIG 5

FIG 5—Microscopic appearance one week following cauterization of bronchus with a 15 per cent solution of silver nitrate. A—Complete stenosis of bronchial lumen. B and B'—100 per cent atelectasis of surrounding parenchyma. (x 7)



FIG 6

Fig 6—H.P. at A, Fig 5. A—Embryonic connective tissue infiltrated with round cells. B—Displaced Cartilage. (x 225)

necrotic and in some places entirely sequestered. There was much evidence of organization as shown by the large amount of granulation tissue and fibroblasts. Marked round-cell and polymorphonuclear leucocytic infiltration was still present (about 50 per cent of each). Much pigment was observed, mostly in phagocytes. Plasma-cells were scattered throughout. The surrounding parenchyma was almost entirely resolved (Figs 8 and 9).

(d) Fifty per cent silver nitrate—one week. The surface of the lung lobe presented the same indurated and injected condition as in the 35 per cent specimen at this stage, except that it was more extensive. The primary bronchus of the lobe showed complete stenosis and the lung lobe was about 75 per cent atelectatic.

Microscopic sections revealed partial regeneration of the bronchial epithelium with much granulation-tissue formation. Elastic tissue, muscle and cartilage were entirely



necrotic. The granulations, as well as surrounding parenchyma were quite heavily infiltrated with round cells and polymorphonuclear leucocytes. Many plasma-cells were present, also phagocytes containing blood pigment. Fibroblastic proliferation was present with reticular connective-tissue formation in some areas. A granular material was seen in the alveoli surrounding the bronchial wall.

(c) Seventy-five per cent silver nitrate—one week. The lung was found to be about 50 per cent atelectatic, the bronchus being occluded with necrotic material (not stenosed by fibrous tissue formation). Much induration was present at the site of the injury. The entire bronchial wall was in the process of sequestration.

Microscopic studies revealed necrosis of the entire bronchial wall and surrounding parenchyma. The necrotic tissue was in process of sequestration. The bronchial lumen contained pus. A heavy infiltration of lymphocytes and neutrophilic leucocytes entirely obliterated the surrounding viable alveoli.

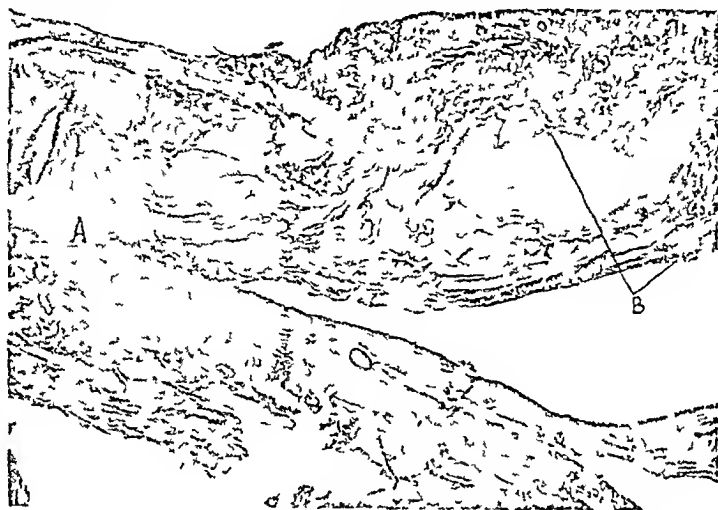


FIG. 7.—Elastic tissue stain of B of Fig. 5. A—Complete lack of elastic fibres at region of stenosis with derangement of cartilages. B—Elastic fibres of uninjured parts ( $\times 25$ ).

More scattered areas of hemorrhage were apparent than in the preceding one-day stage. Little evidence of regeneration was seen.

*Group III (two weeks)*—(a) Five per cent silver nitrate—two weeks. The lung surface appeared normal. The bronchial lumen revealed scarring with partial stenosis at the site of injury.

Microscopic examination showed complete regeneration of the bronchial epithelium. All evidence of recent inflammation had disappeared, leaving some derangement of the component parts of the bronchial wall as the only evidence of the recent injury.

(b) Fifteen per cent silver nitrate—two weeks. The lung surface appeared normal. The bronchial lumen was scarred and partially stenosed.

Microscopic examination revealed the bronchial epithelium completely regenerated. The bronchial musculature and elastic tissue had been partly destroyed without regeneration. Many of the cartilages had become necrotic, some had disappeared, while others were displaced. Marked round-cell infiltration was still present, with fibroblasts and plasma-cells much in evidence. Much granulation tissue was seen and in parts fibrous-tissue formation. The surrounding parenchyma exhibited some infiltration with lymphocytes with partly phagocytized scattered blood pigment.

(c) Thirty-five per cent silver nitrate—two weeks. The lung lobe was about 15 per cent atelectatic. Its bronchus was almost completely stenosed, just admitting a two-millimetre probe. The air passages distal to the stenosis contained some collected mucus which was obstructing the air passage.

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Microscopic examination revealed partial regeneration of the bronchial epithelium. The bronchial musculature and elastic tissue had been completely destroyed with no signs of regeneration. The cartilages had been severely injured, many were absent, and others displaced. Those remaining at the site of the injury presented much evidence of recent injury. Marked lymphocytic infiltration was still present in some areas. A large amount of fibrous connective tissue appeared to be producing a marked stenosis of the bronchial lumen. One division of the main bronchus was completely stenosed. The surrounding parenchyma presented lymphocytic infiltration with some blood pigment present.

(d) Fifty per cent silver nitrate—two weeks. The lung lobe was 100 per cent atelectatic with its primary bronchus completely stenosed. The larger air passages were completely plugged distal to the stenosis with retained mucus.

Microscopic studies presented partial regeneration of the bronchial epithelium. The



FIG 8



FIG 9

FIG 8—Microscopic appearance of bronchial wall and surrounding parenchyma one week following cauterization with a 35 per cent solution of silver nitrate. Note reorganization of A ( $\times 25$ ).

FIG 9—H P at A Fig 8. Note reorganization at A new parenchyma with fresh granulations, and infiltrative process at B near surface of bronchial lumen ( $\times 75$ ).

bronchial musculature and elastic tissue had been completely destroyed with no evidence of regeneration. The cartilages, as in this stage of the 35 per cent silver nitrate studies, had been very extensively damaged. Many had been entirely sequestered, others presented evidence of degeneration and were scattered through the fibrous tissue, producing a stenosis. A variable amount of round-cell infiltration was still present, with marked fibroblastic proliferation and fibrous-tissue formation. The surrounding parenchyma presented a similar picture to that seen in the 35 per cent study of this stage.

(e) Seventy-five per cent silver nitrate—two weeks. The surface of the lung exhibited much bluish discoloration and induration opposite the site of injury. On section of the lobe, the bronchus was markedly stenosed, with the surrounding tissues swollen and hæmorrhagic. Sequestration of the necrotic bronchial wall was in progress. The air passages distal to the stenosis contained retained mucus.

Microscopic examination presented the entire bronchial wall and also a portion of the surrounding parenchyma entirely necrotic and in the process of sequestration. The bronchial epithelium was partially regenerated at the extremities of the injury. Granulation-tissue formation with a small amount of fibrous tissue was present. There was evidence of lymphocytic infiltration with scattered blood pigment. Extensive hemorrhage was apparent in the surrounding parenchyma.

*Group IV (one month)*—(a) Five per cent silver nitrate—one month. The lung lobe grossly appeared normal. The bronchus was about 50 per cent stenosed.

Microscopic examination revealed only a small amount of elastic tissue and bronchial musculature to have been damaged. The cartilages presented some evidence of degeneration, but none was missing. Complete regeneration of the bronchial epithelium had taken place with a tendency to polyp formation. A fair amount of fibroblastic proliferation was in evidence. Most of it was in the formation of connective tissue, as



FIG 10



FIG 11

FIG 10—Photomicrograph one month following cauterization of bronchus with a 50 per cent solution of silver nitrate. A—Complete stenosis of bronchus. B—100 per cent atelectasis of surrounding parenchyma. ( $\times 7$ )

FIG 11—H P at A Fig 10. Note regenerated bronchial epithelium A with the dead cartilages intermingled with the fibrous tissue B to produce complete closure of the bronchial lumen. ( $\times 30$ )

demonstrated by the small number of capillaries present and a large amount of cellular substance. Very few lymphocytes were seen.

(b) Fifteen per cent silver nitrate—one month. Grossly the findings were very similar to those present in the 5 per cent study at this stage.

Microscopic examination also revealed changes comparable to those of the former study, with the exception that the cartilages were somewhat displaced and more evidence of injury in elastic and musculature tissues was apparent.

(c) Thirty-five per cent silver nitrate—one month. The lung lobe was 100 per cent atelectatic. The primary bronchus was completely stenosed with the larger air passages distal to the stenosis plugged with retained mucus.

Microscopic studies revealed partial loss of muscular and elastic tissue. The cartilages were present, but were scattered and showed much evidence of degeneration. The bronchial epithelium had been completely regenerated. Fibrous-tissue formation with intermingling misplaced cartilages produced complete stenosis of the bronchial lumen. Very few lymphocytes were present.

(d) Fifty per cent silver nitrate—one month. The lung lobe grossly presented the same findings as those of the 35 per cent specimen at this stage.

Microscopic examination revealed partial absence of elastic tissue, bronchial musculature and some of the cartilages. Incomplete regeneration of the bronchial epithelium was observed, with the formation of several inclusion cysts. The stenosis appeared

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to be brought about by fibrous-tissue formation with partial collapse of the bronchial wall and by the filling in of the misplaced, partly degenerated cartilages. The surrounding parenchyma was entirely atelectatic. The pulmonary artery lying adjacent to the bronchus revealed destruction of some of its elastic and muscular fibres, with replacement by fibrous connective tissue (Figs 10 and 11)

(c) Seventy-five per cent silver nitrate—one month. The lung surface appeared entirely normal. The primary bronchus was markedly stenosed, apparently in part by granulation tissue.

Microscopic sections exhibited an absence of the entire bronchial wall and a portion of the surrounding parenchyma. The bronchial epithelium was the only constituent seen to be regenerating, and this was incomplete. Much fibrous-tissue formation replaced the destroyed tissue. On the surface of this fibrous tissue, granulations were seen heavily infiltrated by lymphocytes and a fair number of plasma-cells. A good deal of blood pigment was still present, mostly within phagocytes. The surrounding parenchyma was still heavily infiltrated with lymphocytes. A fair amount of œdema and hæmorrhage was also seen, with blood pigment scattered throughout. The pulmonary artery lying next to the bronchus presented more advanced changes but similar to those seen in the 50 per cent specimens at this stage (Figs 12, 13, and 14)

*Comment*—A safe and reliable procedure for closing large bronchi has been presented. This method has been carried out on a large number of dogs (fifty to sixty) with uniform success.

The complete stenosis of a bronchus 0.5 inches in diameter was a routine occurrence within two weeks following the application of a 35 per cent solution of silver nitrate<sup>2</sup>

Smaller bronchi (one-quarter inch) became completely stenosed in from one to two weeks following a single application of a 15 per cent solution. The stenosis in either case was apparently due to partial collapse of the bronchial wall following destruction of its cartilages, with filling of its lumen with granulation tissue which later became fibrous connective tissue. The 50 per cent solution was also followed by the production of complete stenosis in a variable number of cases (70 per cent), however, it was found less safe to use (14 per cent mortality).

This finding was applied in the production of massive atelectasis preliminary to lobectomy and pneumectomy<sup>3</sup>. It also presented a means of closing persistent bronchial fistula produced experimentally<sup>4</sup>.

It has been suggested that it might be used to advantage in closing the primary bronchus of a lobe subsequent to drainage of an abscess from that lobe. This would prevent frequent contamination of the abscess from the tracheo-bronchial tree and might be a valuable aid in clearing up of the disease process, or might act as a preliminary step to cautery pneumectomy or other procedures. Repeated attempts to close the bronchus draining an experimental abscess have been accompanied by failure in each instance.

The value of bronchial stenosis with resultant atelectasis in the treatment of disseminated tuberculosis is under experimental investigation at the present time.

Complete stenosis of the primary bronchus of a lung lobe was accompanied routinely by 100 per cent atelectasis of the lobe. Complete stenosis



FIG 14



FIG 13



FIG 12

FIG 12 —Microscopic appearance one month following cauterization of a bronchus with a 75 per cent solution of silver nitrate A—Extreme degree of fibroblastic proliferation (Fig 13) with some infiltration still present in parenchyma ( $\times 25$ )  
 FIG 13 —H P at A of Fig 12 A—Much fibrous tissue formation with some damage to blood vessel wall (See Fig 14)  
 FIG 14 —H P at A of Fig 12 Elastic tissue stain Note extensive damage to BV wall (A) with loss of elastic tissue and muscular elements and repair by connective tissue formation ( $\times 75$ )

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of only one division of the primary bronchus was never accompanied by atelectasis. This method of producing experimental atelectasis was made use of in a study of that condition.

As in the previous studies, necrosis of the entire bronchial wall was followed by regeneration of only the bronchial epithelium. The rapid rate of regeneration was such that an occasional piling-up of epithelial cells was seen with polyp formation. In other areas, epithelial cells were seen beneath the surface forming inclusion cysts. These phenomena were observed by Winternitz<sup>5</sup> in his studies on intrabronchial insufflation of hydrochloric acid in rabbits.

It was of interest to note that damage to the adjacent pulmonary vessels was present following only the higher percentages (50 and 75) of solution. Whereas four out of nine dogs receiving a 75 per cent solution died of pulmonary hæmorrhage in one to seven days following cauterization, only one out of seven dogs receiving a 50 per cent solution died of pulmonary hæmorrhage. *No deaths occurred when a lower percentage was used.*

In contra-distinction to the previous study on bronchial injury and repair, no infarcts were produced in the present work. It will be remembered that considerable blood-vessel damage accompanied the use of the silver nitrate "stick," which adequately explains the infarct formation.

Unlike the findings of other workers, no pleural exudate accompanied the production of complete atelectasis in our experiments. The difference in methods of production will perhaps explain this phenomenon, as no local irritation or other unphysiologic process was present at the time collapse was being produced.

### CONCLUSIONS

(1) Complete stenosis of a bronchus one-half inch in diameter was the usual occurrence in two weeks following the application of a 35 per cent solution of silver nitrate (15 and 50 per cent less often).

(2) Stenosis of the bronchial lumen was brought about by collapse of its wall and by filling in of the lumen with the injured elements of the wall and granulations, with subsequent fibrous-tissue formation.

(3) Massive atelectasis accompanied complete stenosis of the main bronchus of a pulmonary lobe. No atelectasis was present when all of the main air passages to the lobe were not completely obstructed.

(4) The entire wall of a bronchus became necrotic following cauterization with a 75 per cent solution of silver nitrate. Parts of the wall remained viable when solutions of a lower percentage were used.

(5) The cartilages and elastic tissue were found to be the most resistant to destruction by the solutions employed.

(6) Following necrosis of the entire bronchial wall, only the epithelium was found to regenerate.

(7) Regeneration of the epithelium was very rapid, not infrequently giving rise to polyp and inclusion cyst formation.

(8) Fibroblastic proliferation was very pronounced, especially following 35 and 50 per cent solutions of the chemical

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# TRAUMATIC RUPTURE OF CONGENITAL HYDRONEPHROTIC KIDNEY

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THE so-called congenital hydronephrotic kidney is one type of hydronephrosis usually caused by some form of obstruction at the uretero-pelvic juncture, which develops prior to birth or in early infancy, and in the vast majority of cases manifests itself before the end of the first decade. According to Rovsing, one-third of all cases of hydronephrosis in children are congenital. From a study of 4000 autopsies performed on children, Bugbee found fifty-three cases of this condition and concluded that most of these children die within the first six months of life. Kuster reviewed 500 cases and found fifty-one in children under ten years of age. Campbell, who reported 2000 autopsies on children, found that in 2 per cent of these there was some form of congenital ureteral obstruction and of this number 80 per cent revealed evidence of infection.

A hydronephrotic kidney in a child often escapes recognition, and the failure of diagnosis is due to the fact that such a kidney is usually unaccompanied by fever or urinary changes. The true nature of the lesion is recognized after a careful X-ray and cystoscopic study.

Hydronephrotic kidneys are more prone to spontaneous and traumatic rupture than normal kidneys. Henline, who made an exhaustive study of cases of spontaneously ruptured kidneys, found only twenty-four cases reported in the literature, nineteen of which were operated upon and of which seven died. Of the five unoperated cases, all died. Pierre Bazy reported one case. Connell reported thirty cases, while Amberger reported one case of spontaneous rupture of hydronephrotic kidneys. LeComte reported one case and Miller reports one case of an intraperitoneal rupture of a hydronephrotic kidney. It is, of course, impossible, after reviewing the reported cases, to rule out with absolute certainty the factor of muscular contraction or some form of mild trauma as etiologic factors in any of them.

Traumatic rupture of the kidney is not as rare as was formerly believed. Kuster, from the Clinic at Basle, reports ten cases out of 30,000 admissions, and only 0.12 per cent of 7741 necropsies, and of all cases dying from trauma, only 8 per cent were due to renal injuries. Gutterbock, reporting upon 326 necropsies, found 10 per cent to be due to rupture of the kidney. In contrast with these figures we find today that such an injury is far more frequent, as is, for example, indicated by Delzell and Harrah, who reported a series of eleven cases.

Renal injuries, as evidenced in the literature, are far more frequent in adults than in children. It is also of interest to note that the right kidney



is more frequently involved than the left. Shapiro reports five cases, all of which were on the right side. Gibson reported four cases in children between the ages of eight and twelve, and stated that up to that time only twenty-two cases had been reported. In none of these cases were the kidneys noted as being hydronephrotic. In all of Gibson's cases the lesions were exactly alike in that the kidney was completely divided into two parts, the line of rupture running vertical to the long axis at the junction of the lower two-thirds, and he explains this on the theory of bursting by hydraulic pressure.

*Etiology* —The relative rarity of this lesion in children is due to the lack of exposure of children to the various types of trauma commonly encountered by adult males. The weight of opinion seems to favor Kuttner's theory that as the kidney is a semifluid body, it will tend to burst, under favorable circumstances, along the line of least resistance, following the law of hydraulics. At times, the extent of the renal damage bears no relationship to the severity of the trauma, as is so well shown in two of Gibson's cases, where the severest type of renal damage was unaccompanied by any marks of external violence on the surface of the body.

In children, as in adults, rupture may occur from direct violence during which the kidney is thrown against the lower ribs or against the transverse processes of the upper two lumbar vertebrae, or from indirect violence as in the case of a person who lands upon his feet after a fall, from sudden muscular contraction or spontaneously. The latter, although very interesting and rather unusual as previously outlined, will not bear too careful scrutiny, since it is well nigh impossible to rule out the element of muscular contraction or mild forms of trauma so frequently overlooked by patients.

*Pathology* —A trauma of the kidney may, as indicated by Bugbee, result in (a) slight laceration of the fatty capsule, (b) subcapsular hæmorrhage, (c) contusion or laceration of the parenchyma, (d) complete laceration or pulpification of the kidney, (e) complete or incomplete laceration of the pelvis, ureter and pedicle, (f) tear of the peritoneum, or (g) an injury to other viscera. Contrary to expectation, the extent of the renal damage does not always depend upon the severity of the trauma producing it. At times a severe trauma will only produce a subcapsular rupture which will subside in a few days and give no further trouble, and at other times a mild injury will result in a complete rupture with laceration of the renal pedicle and lead to exsanguination or to a penetration of the peritoneum and a fatal peritonitis.

A subcapsular renal rupture will, if permitted to go untreated, lead to an accumulation of blood under the capsule, which will eventually result in an automatic tamponade of the kidney and a cessation of the hæmorrhage, and finally to an absorption of the extravasation, connective tissue replacement of the destroyed renal parenchymal elements and to spontaneous recovery.

Where the rupture is complete, that is, where the tear is through the capsule, blood and urine escape into the perirenal tissues and form a retroperitoneal collection of considerable size, which can often be felt as an elastic

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tumor In those cases where the peritoneum is capable of withstanding the increasing pressure of the extravasated fluid, the pressure will eventually reach a point where it will equalize that existing within the bleeding vessel and the hæmorrhage automatically ceases. If such a case is permitted to go untreated, one of two things may happen. In favorable cases the exudate is absorbed and the patient recovers. On the other hand, should infection supervene, the patient may succumb to general sepsis, or, by direct extension, to a fatal peritonitis. When the rupture includes the peritoneum, the patient may die of hæmorrhage or peritonitis.

Although most traumatized kidneys lead to hæmaturia, this is not an invariable finding since it is possible for some of the collecting tubules in the renal parenchyma to become occluded by clots and thus prevent blood from entering the pelvis and ureter. Similarly, if there is a complete severance of the pelvis from the ureter, it is obvious that blood will be unable to reach the bladder. Where a communication exists between the kidney and peritoneal cavity, bleeding will take place there and not in the bladder. It is for these reasons that Vielcker claims that hæmaturia is not a constant symptom in rupture of the kidney.

The finding of a small spot of ecchymosis may at times lead to the suspicion of a traumatic lesion involving the kidney. The ecchymosis may be situated in the skin over the lumbar region, or, due to burrowing of the extravasation, along the fascial planes, may be found in the thigh, over the base of the penis, scrotum or in the perineum, as was seen in one of the cases reported by Delzell and Harrah.

*Symptoms*—The three outstanding symptoms associated with rupture of the kidney are pain, hæmorrhage and tumor. Pain may be mild or severe, and at times assume the character of renal colic radiating to the thigh or bladder. Fieschi reported a case where the pain was on the opposite side to the side of the lesion. The intensity of the pain bears no relationship to the severity of the renal lesion, since kidneys almost completely pulpified may be accompanied by little pain. This phenomenon is explained by the fact that the renal parenchyma as shown by Papin is devoid of sensory nerves, so that any pain which is experienced is due to tension produced by the extravasation or to the passage of clots down the ureter.

Although the presence of a swelling in the loin is evident in most cases, it is absent where the renal laceration is associated with a rent in the peritoneum. The swelling which is soft and fluctuant is situated in the loin, may be small or large, and is due to an extravasation between the kidney and the peritoneum. The presence of such a tumefaction is often obscured by the rigidity of the overlying abdominal and lumbar muscles. Hæmaturia which is present in most though not all of the collected cases may be constant or intermittent. It may be profuse or scanty and the extent of the hæmaturia is at times out of all proportions to the severity of the lesion. Shock is a variable feature. When present it may be due to the renal injury, to hæmorrhage, peritoneal irritation or to associated injuries to other organs. Fever

accompanies infection and is often present in the later stages during the absorption of the extravasation

A history of a pre-existing enlargement of a kidney in a child suggestive of hydronephrosis will often give a valuable clue to the existence of a laceration in cases of spontaneous rupture or rupture following some trivial trauma

*Diagnosis*—A tentative pre-operative diagnosis of rupture is possible in cases where a history of trauma is elicited along with the three outstanding symptoms, namely, pain, hæmaturia and a fluctuating mass in the loin. An absolute diagnosis can be made if, along with the foregoing features, positive pyelographic data are obtainable, such as the finding of the dye outside the renal silhouette or distributed through the renal parenchyma

*Treatment*—The treatment of rupture of the kidney falls into three groups: (a) conservative non-operative or expectant, (b) conservative operative, (c) nephrectomy. The type of treatment must of necessity depend upon the existing pathology. Cases of laceration of the fatty capsule, or mild contusions or subcapsular lacerations of the parenchyma call for nothing more than a few day's rest in bed, and the application of ice-bags to the traumatized side. Surgical intervention is indicated only when the patient, who is placed upon careful expectant treatment, continues to show signs of progressive hæmorrhage or shock. In such cases the employment of conservative or radical surgery depends entirely upon the lesion present in the exposed kidney. Certain lacerations, especially those in which the rent has not involved the vascular pedicle of the kidney, can be well treated by packing or suture, or by a combination of both, associated with ample drainage. Nephrectomy must be performed upon those cases where the kidney is hopelessly pulpified, the pedicle torn or the pelvis severed from the ureter, or in those cases where the injury has occurred in congenital hydronephrosis or in other hopelessly diseased kidneys.

In the event of peritoneal damage, laparotomy must be performed, and it is here where the ingenuity of the surgeon is taxed to the utmost, especially in those cases where doubt exists as to whether the lesion is entirely extra or both extra and intraperitoneal. It is the writer's belief that, in those cases where it is impossible to ascertain the presence of intraperitoneal leakage or damage in addition to the renal injury, it is best to perform a laparotomy for the purpose of thorough exploration and the establishment of appropriate drainage if necessary, before exposing the kidney through the lumbar route. It is not considered good practice in this type of case to explore the kidney transperitoneally. A much safer procedure is to drain the retroperitoneal extravasation through the lumbar route. In cases where doubt exists regarding the advisability of saving the kidney, it may be best to drain the exudate at the first operation and, if nephrectomy becomes necessary, to perform it at a subsequent date when the patient's condition has improved and the risks of infection reduced. This is especially true in cases of rupture of a congenital hydronephrotic kidney where at operation the kidney has collapsed into a small sac, making nephrectomy difficult and hazardous.

## RUPTURE OF HYDRONEPHROTIC KIDNEY

CASE REPORTS —CASE I—M G, male child, aged six years, was first seen September 3, 1930, complaining of pain in the right lower quadrant of the abdomen and vomiting of two days' duration. Three years previously the abdomen was explored for suspected appendicitis. A normal appendix was removed but the operating surgeon reported finding a polycystic kidney on the right side, no comment being made on the condition of the left kidney. Three weeks ago, he suffered a convulsion.

Two days prior to present consultation, while playing, he struck his abdomen against an iron bar. Immediately after the accident he complained of pain in the right side of the abdomen and vomited. The pain in the abdomen and vomiting continued and the temperature rose to  $102^{\circ}$ . There was no hæmaturia. Examination of the



FIG 1—Case I. Right pyelogram showing obliteration of normal landmarks of pelvis and calices.

abdomen revealed diffuse tenderness, most marked over the right iliac fossa and right loin, and rigidity of the abdominal musculature, especially the right rectus with a positive rebound. The muscles over the right lumbar region were also spastic. Temperature,  $101^{\circ}$ . Pulse, 120. Blood-count showed 30,000 leucocytes per cubic millimetres of which there were 60 per cent segmented neutrophils and 14 per cent band-forms, 14 per cent small lymphocytes and 2 per cent monocytes. Urinalysis showed a faint trace of albumin, a few leucocytes, an occasional hyaline cast and 2 plus urobilin. There were no red cells.

From the history and physical signs, it was impossible to rule out an intra-abdominal lesion. The history that another surgeon had found a polycystic kidney on the right side in the course of an abdominal exploration led to a strong conviction that we

were dealing with a primary lesion involving the right kidney. It was decided first to rule out any intra-abdominal pathology by performing a preliminary laparotomy to be followed immediately by an exploration of the kidney through the usual lumbar route.

*Operation*—September 2, 1930. Under general anaesthesia the abdomen was opened through a three-and-a-half inch right rectus muscle-splitting incision. Situated behind the ascending colon and lifting it away from the posterior abdominal wall there was a large retroperitoneal, dark mahogany-colored extravasation. There was no evidence of leakage into the peritoneal cavity. The abdomen was quickly closed in layers and the patient turned on the left side, and through a three-inch Albarran incision the right renal fossa was exposed, revealing a large collection of blood and urine. This was removed by suction. In place of a palpable renal mass, a small collapsed sac was

felt which appeared to be the remains of the kidney. In view of the condition of the patient, and lack of information concerning the exact state of the other kidney, it was thought advisable to drain the wound and terminate



FIG 2—Case I. Photograph taken of kidney immediately after removal.



FIG 3—Case I. Kidney opened showing complete atrophy of renal parenchyma.

the operation at this time. Two rubber tubes and one dam were introduced and the wound closed in layers.

Blood chemistry: September 3, urea N, 13.5, creatinin, 1.6, glucose, 79. September 18, urea N, 6.7, creatinin, 1.2, glucose, 77.

Both wounds were healed on September 22, 1930, and the patient was permitted out of bed. On September 26, uroselectan was given intravenously. The roentgenograms revealed a failure of the right kidney to take the dye. Although the left renal pelvis was somewhat dilated, the pyelogram failed to reveal any features suggestive of polycystic disease. Repeated urinalyses were negative. Patient was discharged September 27.

On December 13, 1930, the child was seen again. Since his discharge from the hospital he had gained weight and felt well. He voided six times during the day and did not have to void during the night. At 6 A. M. on the day of the present examination the patient voided bloody urine. The mother stated that four days previously, while plying, he again struck his right flank against a chair.

## RUPTURE OF HYDRONEPHROTIC KIDNEY

Cystoscopy revealed many red blood-cells and clumps of pus-cells in the urine from the right kidney while that from the left was negative. Bilateral shadowgraphy was negative. Right pyelography showed a completely destroyed hydronephrotic kidney (Fig 1)

*Operation*—December 17, 1930. The right kidney was exposed through a four inch Albarran incision. The kidney was enormously enlarged and converted into a thin-walled sac. The pelvis was also enormously dilated and the ureter appeared to be implanted into the posterior wall of the pelvis, so that it formed an acute angulation upwards and backwards from the most depended portion of the pelvis. The uretero-



FIG 4—Case II. Right pyelogram showing irregular distribution of the dye through the renal silhouette.

pelvic opening was very minute. The kidney was easily removed and the wound closed in layers after draining the renal fossa.

*Pathological Report*—Specimen is a kidney measuring 12 by 8½ by 5 centimetres. The surface is bluish-gray, and presents many fibrous adhesions. The kidney is converted into a fluid sac with a thin parchment-like wall. The pelvis is much dilated and the uretero-pelvic orifice, which is situated on the posterior pelvic wall, is very small. On section, the kidney appears like a thin-walled sac containing several loculi lined with a smooth, light gray membrane. The cortex is from two to three millimetres in thickness and contains very little recognizable renal tissue. Sections made through the sac wall show some remains of renal tissue with much fibrosis and inflammatory exudate. *Diagnosis*—Complete hydronephrosis (Figs 2 and 3)

Following an uneventful convalescence, patient was discharged from the hospital January 5, 1931

*Comment*—This case deals with a boy six years of age who, following an injury to the abdominal wall, sustained a rupture of a congenital hydronephrotic kidney. In spite of the suspicion entertained pre-operatively regarding the nature of the injury, the signs and symptoms pointed so strongly to an intraperitoneal lesion that laparotomy had to be performed in order to rule out such a lesion before exposing the kidney through a lumbar incision. Exploration of the renal region revealed a collapsed, ruptured, hydronephrotic sac with a large retroperitoneal extravasation which was drained at the first operation, and followed by nephrectomy at a subsequent date. It is noteworthy that at no time during the first episode was hæmaturia noted. This symptom occurred prior to the second operation, at which time the kidney, although supposedly traumatized, was not ruptured.

CASE II—A G, aged fifteen, was first seen January 16, 1928, complaining of hæma-



FIG 5—Case II Photograph of kidney showing dilation of pelvis, atrophy of renal parenchyma, and rent in pelvis

turia of ten days' duration. Past history was negative save for a dull pain in the right flank on and off for several years.

While playing basketball ten days previously, he was struck a light glancing blow on the abdomen, following which he passed a small amount of bloody urine. Hæmaturia persisted for twelve hours, following which he was without symptoms for one week. Three days previously he was again struck a light blow on the abdomen while playing basketball following which he collapsed. A physician who saw him immediately after the accident found him in shock, from which he quickly emerged after mild stimulation. Since then his urine has been bloody. There was no frequency, dysuria or backache. Temperature, 100° Pulse, 80 per minute.

Cystoscopy revealed a normal bladder. Both kidneys were easily catheterized. There was no flow from the right catheter. Urine from the left kidney contained an occasional red blood-cell and showed good dye concentration.

## RUPTURE OF HYDRONEPHROTIC KIDNEY

On the rontgenogram the tip of the opaque catheter was seen to impinge at a point one-half inch above the iliac crest. Right pyelogram showed a complete distortion of the pelvic contour with the dye scattered throughout the renal fossa. The left renal silhouette appeared normal. (Fig 4)

Physical examination was essentially negative save for right costovertebral tenderness and spasticity of the lumbar musculature. A pre-operative diagnosis of ruptured kidney was made and operation advised.

*Operation*—The right kidney was exposed through a six-inch Albarran incision. The kidney felt soft and boggy and consisted mostly of a large dilated pelvis with very little renal parenchyma. On the ventral surface of the pelvis there was a rent about one inch in length. The entire pelvis was filled with blood clots and there was a large blood-stained extravasation in the perirenal tissues and retroperitoneal space extending down behind the ascending colon. The renal pedicle appeared to enter the kidney near its upper pole. (Fig 5)

The kidney was removed and the perirenal space drained. Following a stormy convalescence with temperature ranging between  $99^{\circ}$  and  $103^{\circ}$ , the patient was discharged well on January 31, 1928—fifteen days after operation.

*Comment*—This case deals with a boy fifteen years of age who sustained a rupture of a hydronephrotic kidney undoubtedly congenital in origin, following a slight trauma during a basketball game. Although hæmaturia was noted following the accident, it persisted for only twelve hours and apparently resulted in little discomfort. One week later, following a second injury, he collapsed and at operation a ruptured hydronephrotic kidney was removed. The probabilities are that during the first trauma the kidney sustained only a subcapsule laceration which perforated after the second trauma, resulting in a retroperitoneal extravasation.

### SUMMARY AND CONCLUSIONS

(1) The incidence of rupture of congenital hydronephrotic kidneys is small.

(2) Kidneys in children which rupture as a result of mild traumata are usually hydronephrotic.

(3) So-called spontaneous rupture of kidneys may be due to mild forms of trauma easily overlooked by patients. They are very rare, as attested to by a paucity of cases reported in the literature.

(4) Hæmaturia is not a cardinal symptom in rupture of the kidney.

(5) The presence of ecchymotic areas over the skin of the loin, thigh, penis or perineum may be suggestive of a renal injury.

(6) Exploratory laparotomy is indicated in all cases where doubt exists regarding the presence of an intra-abdominal lesion associated with the renal injury. The kidney should be exposed and explored through a second incision in the loin.

(7) Retroperitoneal extravasations are best drained through the lumbar route rather than transperitoneally.

(8) Conservative surgery cannot be employed in cases of ruptured congenital hydronephrotic kidneys, nephrectomy being the procedure of choice.

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# CYST OF THE PANCREAS ASSOCIATED WITH ECTOPIC SPLENIC ISLAND

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THE first successful removal of a pancreatic cyst was reported in 1881 by Bozeman<sup>1</sup> before the New York Pathological Society. The next year, Gusenbauer devised the operation of marsupialization, which is still the commonest method of surgical treatment. Senn<sup>2</sup> reported a case successfully treated by surgery in 1885 and attempted to produce cysts experimentally by tying off the pancreatic duct. Lazarus<sup>3</sup> produced a cyst in the pancreas of a dog. He crushed the pancreas and caused the formation of a hæmatoma about the size of a pigeon's egg, which, after forty days, was converted into a cyst with a smooth, fibrous capsule containing 100 cubic centimetres of a watery fluid. Others attempted to produce cysts experimentally by injecting various substances into the duct of Wirsung. Opie<sup>4</sup> called attention to the relationship between diseases of the pancreas and obstruction to the normal outflow of bile by a stone in the common bile-duct. Eha<sup>5</sup> has reported a cyst the size of an orange in an infant five months old. He believed it to be a congenital cyst. Railton<sup>6</sup> and Shattuck<sup>6</sup> report similar cases in infants. Robson and Moynihan<sup>7</sup> refer to three cases and state that congenital cystic disease of the pancreas is exceedingly rare. The case I wish to report is especially interesting from the standpoint of etiology because of a congenital anomaly found in the pancreas post-mortem.

CASE REPORT—E. K., a cabinetmaker, sixty-one years of age, was admitted to the Albany Hospital December 9, 1929, into the service of Dr. A. H. Traver. His past history and family history were negative. He had always considered his health good, and his habits were temperate. Five weeks before admission he had severe pain across the upper part of his abdomen and vomited persistently for three days. He attributed this upset to some sardines that he had eaten. There was no jaundice. He had one chill but thought he had had no fever. Following this attack he had no more pain, but his appetite failed, and he felt weak. He noticed that his abdomen began slowly to increase in size. At the time of admission to the hospital his temperature and pulse were normal. He complained only of weakness and the swelling of his abdomen. There was no history of injury.

The physical examination was essentially negative except for a mass filling the upper half of the abdomen. This was smooth and was dull to percussion. No fluid wave or shifting dullness in the flanks could be made out. No definite edge could be felt. There was no apparent enlargement of the liver. The mass was not movable. There was no pulsation or bruit. A twenty-four-hour specimen of urine was negative for sugar, and each of four single specimens collected before and after operation were negative for sugar. The tests for albumen, acetone, and diacetic acid were negative. Examination of the blood showed 4,500,000 red cells and 8,600 white cells, with a normal differential. Hæmoglobin was 70 per cent by the Tallquist scale. The blood Wassermann

was negative. Fasting blood sugar was 112 milligrams and the non-protein nitrogen was 54 milligrams per 100 cubic centimetres. X-ray examination after a barium meal showed no constrictions or filling defects. The transverse colon was displaced downward by a large rounded mass above it. The greater curvature of the stomach was indented by this same mass. The X-ray findings suggested a large mass outside the gastro-intestinal tract, probably a retroperitoneal tumor.

The pre-operative diagnosis of pancreatic cyst was based on the location of the tumor and its steady increase in size over a period of five weeks after an attack of upper abdominal pain, whose severity and radiation from right to left suggested an acute pancreatitis. In making a diagnosis, the following possibilities were considered: Retroperitoneal cyst or cyst of the mesentery, echinococcus cyst, splenomegaly, aneurism of the abdominal aorta, and ascites. Hydronephrosis or pyonephrosis seemed to be ruled out by the examination of the urine and the fact that the mass did not extend into the flank so as to fill the costovertebral angle when palpated bimanually.

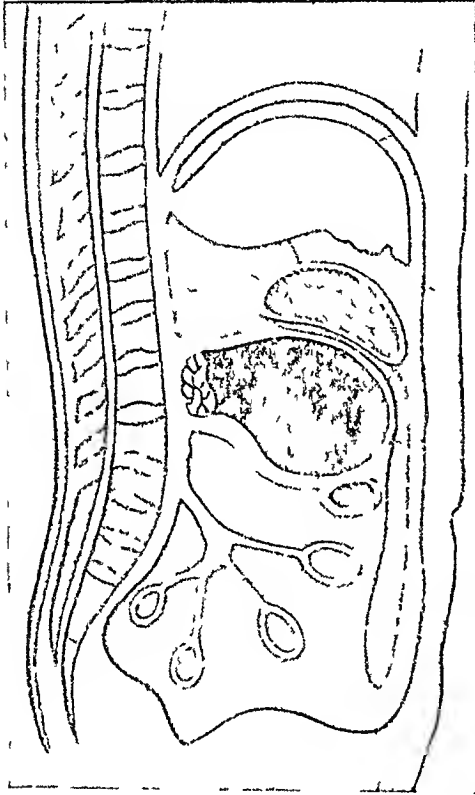


FIG. 1.—Cyst projecting forward from pancreas and presenting between stomach and colon. (From Robson and Cammidge.)

On December 11, operation was performed by Dr. A. H. Traver under ether anaesthesia. When the peritoneum was opened through an upper left rectus incision, a cystic swelling presented itself at once. It was the size of a football and protruded between the stomach and the transverse colon. There were adhesions about the gall-bladder. Palpation revealed that the cyst was separate from stomach, kidney, spleen, and liver. It was approached through the lesser peritoneal cavity by making an opening in the mesocolon. No fat necrosis was seen. The cyst was thin-walled, and fluid leaked out when an attempt was made to put in purse-string sutures, so gauze was packed about the cyst and an Ochsner's trocar was introduced. About a quart of thin, muddy fluid, which looked as if it contained old blood, was drawn into a basin, and then it was possible to enlarge the opening in the cyst and stitch it to the edge of the parietal peritoneum (*i.e.*, marsupialization). A large tube was fastened in place to drain the cyst, and fifteen ounces of fluid were collected in

the first twenty-four hours. A stab wound was made at a lower point in the abdomen, and a "cigarette" wick was inserted before closing the primary incision. The fluid from the cyst was examined by Professor Arthur Knudson for amylase by the method of T. R. Brown,<sup>8</sup> using starch and iodine to determine the enzyme action. Only 0.8 per cent of the amount in normal pancreatic juice was found.

The immediate post-operative recovery was good. There was profuse drainage for a week. After four or five days the tube became loose and fluid escaped around the tube in sufficient quantities to soak the dressings, the binder, and the bed linen. The skin was protected by zinc oxide ointment to prevent digestion about the wound. The patient was cooperative and took large quantities of liquids. Normal saline was given by rectum and by hypodermoclysis. When the temperature rose on the fifteenth day after operation, the wound was irrigated, and chunks of digested tissue, a cheesy material, were washed out. A week later, twenty-one days after operation, the patient died of pulmonary embolism.

## CYST OF PANCREAS

*Necropsy Report*—An autopsy was performed by Dr Victor C Jacobsen only thirty minutes after death, which was fortunate inasmuch as there are very rapid changes in the pancreas post-mortem. The important findings were: A left rectus operative incision 16 centimetres long, 4 centimetres to the left of the umbilicus. From the upper end of this wound a purulent material exuded, and the wound was partly open. To the inside of the wound the omentum was adherent, and small white areas of fat necrosis were scattered in the omentum, the anterior abdominal wall, the mesentery, and about the upper part of the abdominal cavity. There were dense adhesions about the spleen, the appendix, and the gall-bladder. Anterior to and slightly below the pancreas was a large cavity lined by an injected membrane. The cavity extended the entire length of the pancreas, it had dissected down to the pole of the left kidney, included the entire lesser peritoneal cavity, and extended into the omentum. In the lumen of the cavity was



FIG 2—Wall of pancreatic cyst. To the left are much fibrosis and lymphocytic infiltration.



FIG 3—A section of the pancreas. In the central portion is an island of splenic pulp in the capsule of which are several dilated pancreatic ducts.

a grayish, caseous, soft substance, resembling necrotic fat. A sinus connected this cavity with the abdominal wound described above. The entire mass was removed and cross-sections made to show, if possible, any connection between the cavity and the pancreatic ducts, but none could be demonstrated. The larger pancreatic ducts were dilated but probing revealed no obstruction. There was considerable fat necrosis throughout the entire gland. Microscopic examination of the pancreas shows much chronic interacinar and interlobular inflammation, also dilatation of some ducts, but many are quite normal. There is hyperplasia of the lining epithelium of some ducts. In one section there is an *ectopic focus of splenic pulp entirely surrounded by pancreatic tissue*. The islands of Langerhans appear normal. In the interlobar fat and capsular fat are large areas of necrosis with moderate inflammatory reaction, but no hæmorrhage. There are cholesterol and hæmatoidin crystals and calcareous salts in some of these areas. The large tract found leading in various directions from the pancreas and down into the mesentery is lined by necrotic tissue and degenerated fat, but no definite epithelial lining is found except a few cells in one section. The conformation of the tract and the finding of ectopic splenic tissue in the pancreas suggest the possibility of some congenital anomaly of pancreatic ducts with cyst formation and subsequent rupture of the cyst, the contents dissecting in various directions and liberating fat-splitting enzymes.

The gall-bladder was markedly dilated, the bladder wall slightly thickened, and the mucosa covered with cholesterol deposits. In the lumen of the gall-bladder were about ten small cholesterol stones. The bile-ducts were markedly dilated, but patent. The right lung weighed 340 grams. There was thrombosis of nearly all branches of the pulmonary artery.

*Discussion* —Pancreatic cysts are rather rare inasmuch as White<sup>9</sup> found only three cases in 6,078 autopsies performed at Guy's Hospital in London. They have been classified by Robson and Cammidge<sup>10</sup> as follows

(1) Retention cysts, which are lined with epithelium and are caused by obstruction in the pancreatic duct, smaller ducts or acini

(2) Proliferation cysts, due to a proliferation of glandular epithelium followed by an accumulation of fluid. These are true tumors (cystadenoma or cystic epithelioma)

(3) Congenital cysts, analogous to those found in liver, spleen, or kidneys

(4) Hæmorrhagic cysts, due to hæmorrhagic necrosis

(5) Hydatid cysts

(6) Pseudocysts, produced by trauma or degenerative changes of the interstitial tissue of the pancreas. They are distinguished from true cysts in that they are not within the substance of the pancreas but are usually in the lesser omental sac

(7) Dermoid cysts

*Contents and Location of the Cyst* —The contents of pancreatic cysts vary. The fluid is ordinarily alkaline and has a specific gravity of 1.010 to 1.020. The fluid may be perfectly clear, though usually blood is present, often having undergone marked changes to a dark chocolate or coffee-ground appearance. In the case presented above, there was evidence of old hæmorrhage. The fluid frequently contains one or more of the pancreatic ferments, and it is possible that all three may be present. However, an absence of the ferments does not in any way indicate that a cyst is not of pancreatic origin, for the ferments frequently disappear in the old cysts, often reappearing in the discharge when the cyst is drained<sup>11</sup>. The contents of the pseudocyst are produced by liquefaction of necrotic tissue together with a bloody and inflammatory exudate.

The cysts are frequently located between the stomach and the transverse colon or above the stomach, and less frequently between the layers of the mesocolon. However, they may occupy any part of the abdominal cavity and frequently simulate ovarian cysts.

*Etiology* —The pancreas crosses the body of the first lumbar vertebra and may be injured when there is compression of the abdomen, particularly if the abdominal muscles are relaxed and the stomach is empty at the time of the accident<sup>12</sup>. Injury to the pancreas is frequently overlooked when there is an associated injury to other abdominal viscera. According to Heiberg,<sup>13</sup> in one-third of all cases of pancreatic cysts trauma was the cause of the trouble. The enlargement usually appears at once, but it may occur months later, according to Honigman<sup>14</sup>.

Senn classifies the causes of retention as follows

(1) Obstruction to the outflow of the secretion from impaction of pancreatic calculi in the pancreatic duct or of biliary calculus in the ampulla of Vater

## CYST OF PANCREAS

(2) Partial or complete obliteration of a portion of the pancreatic duct from cicatricial contraction

(3) Sudden or gradual obstruction of the duct without diminution of its lumen from displacements of the pancreas. Such a displacement may be the result of relaxation of the attachments to surrounding structures, to pressure on the gland from tumors or exudation, or to cicatricial contraction in the substance of the gland.

Hæmorrhage seems to be an important etiologic factor in many cases (Warnock,<sup>15</sup> Lloyd<sup>16</sup>), as a hæmatoma has been found in the substance of the pancreas during exploration of a pancreatic cyst. Many of the pseudocysts, according to Lloyd, are fluid effusions into the lesser peritoneal sac, the result of injury to the underlying pancreas, and not cysts of the pancreas in the proper meaning of the term. Other cases seem to follow an acute pancreatitis, which in turn may be due to a plugging of the ampulla of Vater with a gall-stone and the back flow of bile into the pancreas.<sup>4</sup> Experimentally, however, Mann and Giordano<sup>17</sup> have found it impossible to produce a pancreatitis by such means unless bile is injected directly into the duct of Wirsung under considerable pressure, and then they assume the inflammation and subsequent cyst formation are due to rupturing of some of the small ducts and an escape of pancreatic fluid rather than bile alone.

*Diagnosis*—The diagnosis can be made only when the cyst has attained considerable size. Pain is not a constant symptom unless it comes from pressure or from associated conditions. In non-traumatic cases the history may suggest an acute or chronic pancreatitis or a biliary colic preceding the development of the cystic tumor. Frequently, the patient complains only of the increasing swelling of the abdomen with loss of appetite. There may be large fatty stools, and there may be sugar in the urine, but these findings are often absent if the pancreatic function is maintained.

Physical examination reveals a rounded, firm, smooth tumor of varying size in the epigastrium. It moves with respiration and is separate from liver, spleen, or kidney. The tumor may be fluctuant and may transmit the pulsations of the abdominal aorta. It is not usually tender. The stomach can usually be made out by percussion lying above the tumor and to the left, and sometimes the transverse colon can be made out passing anterior to it. When the cyst fills the abdomen, there may be a fluid wave, but there should be no shifting dullness in the flanks. A rectal or vaginal examination should help to distinguish between pancreatic cyst and ovarian cyst.

*Treatment*—The treatment of these cases is always surgical and is most often simple drainage after drawing the cyst up into the wound and stitching it to the parietal peritoneum at the edge of the incision (*i.e.*, marsupialization). In some cases the operation has been done in two stages, but this is not often necessary. Aspiration by means of a trocar or needle inserted through the intact abdominal wall is no longer considered good surgery as the stomach or transverse colon may be compressed and intervene. Excision of a part or the whole of the cyst would seem advisable if this were possible.

without producing an extensive hæmorrhage. Prolonged drainage is indicated<sup>18</sup>. The mortality of such operations is from 20 to 30 per cent. A few patients require a secondary operation because the cyst refills or because of malignant degeneration. Occasionally, the sinus formed after an operation refuses to heal, and when a total loss of pancreatic secretion occurs, this is a serious matter producing dehydration, emaciation, extreme weakness, a diarrhoea with large fatty stools, and finally death. Radium has been used with good results in a few cases to promote fibrosis and healing when there is a persistent sinus<sup>19</sup>.

## SUMMARY

(1) A case of cyst of the pancreas is reported in a man of sixty-one years, who died twenty-one days after operation, of pulmonary embolism.

(2) The cyst had ruptured, the contents causing widespread fat necrosis. The lining of the cyst suggested an origin from pancreatic ducts, with possibly a congenital anomaly of ducts as a basis for the condition. This hypothesis is supported by the presence of another anomaly, splenic tissue within the pancreas.

(3) Other theories of etiology are discussed.

(4) Treatment consists of early operation with prolonged drainage. Complications are frequent.

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# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD APRIL 22, 1931

The President, Dr EDWIN BEER, in the Chair

### JEJUNO-COLIC FISTULA FOLLOWING GASTROENTEROSTOMY GASTRECTOMY

DR CONSTANTINE J MACGUIRE presented a man forty-three years of age who was admitted to the Medical Division at St Vincent's Hospital October 29, 1929. He had been operated on in the hospital two years previously for chronic duodenal ulcer. The gastroenterostomy performed at that time was followed by freedom of symptoms and progressive gain in weight and strength until nine months previous to this second admission when he was suddenly seized with weakness, repeated vomiting of bright red and dark blood, tarry stools and also stools containing bright blood and marked epigastric pain at about the umbilical level just to the left of the mid-line. After two weeks in bed he was relieved until one month before admission, when he collapsed with a recurrence of all the former symptoms.

An X-ray series showed evidence of obstruction and inflammation beyond the gastroenterostomy stoma with a six-hour retention. At operation, November 19, 1929, there were found at the first portion of the duodenum a cicatrix, causing almost complete constriction at the pylorus, and a very small duodenum. No evidence of recent or acute ulceration in the duodenum. About 2 centimetres beyond the gastroenterostomy stoma there was an ulcer which had perforated the wall of the jejunum and the posterior wall of the transverse colon, forming a jejuno-colic fistula about 1 centimetre in diameter, well protected by peritoneal adhesions. Surrounding this ulceration and fistula there was much induration in the adjoining wall of the colon and jejunum, extending to and involving the gastroenterostomy stoma. There were many enlarged inflammatory lymph-nodes and there was induration and chronic inflammation extending down to the mesentery of the jejunum, up into the mesocolon and the lesser peritoneal sac. The stomach was dilated. Since repair of the jejuno-colic fistula would require resection of the jejunum and the obliteration of the old gastroenterostomy stoma, subtotal gastrectomy seemed indicated. The entire involved portion of jejunum was then resected and the lumen restored by end-to-end anastomosis. A subtotal gastrectomy was then performed, end of stomach to side of jejunum, well beyond the resected area. More than the distal half of the stomach was resected. Because of the fact that the field had been contaminated by the operation on the fistula into the colon, the wound was drained.

A few days after operation a fecal fistula manifested itself but under open treatment with dry heat this closed up in a couple of weeks, and since that time patient has been free from symptoms referable to his intestinal tract.

Check-up X-rays were taken about two weeks ago and were interpreted as follows: "An examination of the stomach to determine its emptying time after operation revealed the following: The remaining portion of the stomach

## JEJUNAL FISTULA TO ANTERIOR ABDOMINAL WALL

was dilated, its pyloric segment and a portion of the middle pole having been resected in the operation of November, 1929. The anastomosed area between the gastric stump and the jejunum was fairly well visualized and the barium mixture passed from the stomach into the dilated jejunum within the normal six-hour period. At the end of six hours the bulk of the barium mixture was in the proximal colon and the head of the column was entering the transverse colon. Small traces of barium could be seen in the upper abdomen, probably in the region of the proximal jejunum."

This case is shown as one of the unfortunate and apparently unavoidable results occasionally following gastroenterostomy, where the original lesion is cured only to be replaced by a very much more serious one. The mortality of jejuno-colic fistula is high. The diagnosis in this case was aided by the presence of fresh blood in the stools as well as in the vomitus, the great severity of the pain and its location just to the left of the umbilicus. The subtotal gastrectomy was done anterior to the colon because this operation does not constrict the colon, and in case of further trouble the anastomosis is easily accessible directly under the anterior abdominal wall.

## JEJUNAL FISTULA TO ANTERIOR ABDOMINAL WALL

DOCTOR MACGUIRE presented a woman who was admitted to the First Surgical Division of Bellevue Hospital on January 14, 1931. She had been operated upon at the Presbyterian Hospital by Doctor Lambert in 1921 for a pre-pyloric ulcer. He performed a pylorectomy followed by an anterior Polya anastomosis, end of stomach to side of jejunum. A year later she returned to the Presbyterian Hospital suffering from symptoms which were judged to be due to jejunal obstruction, and for this Doctor Whipple performed a jejuno-jejunostomy between the two arms of the jejunal loop of the anastomosed portion of the jejunum. This was followed by relief of all symptoms until three years ago, when she developed recurrent attacks of pain relieved by food and sodium bicarbonate.

In the last year, the pains had been just above the umbilicus, and without definite relation to food, but relieved somewhat by local pressure. The pains had been getting worse, and for four months before the last admission she had failed to get relief. Operation was performed January 21, 1931. Very massive organized adhesions were found between the stomach, liver, jejunum, transverse colon and anterior abdominal wall, just beyond the gastrojejunal stoma, and proximal to the jejuno-jejunostomy of eight years before. There was a perforated jejunal ulcer adherent to the anterior abdominal wall, where there was a walled-off perforation, the base of the crater being in the anterior wall.

With much labor the ulcerated jejunum was freed from the anterior abdominal wall. The jejuno-jejunostomy of eight years ago was left intact, but the afferent and efferent loops of jejunum going to the anterior gastro-jejunostomy of eleven years ago were divided between clamps, and the jejunal opening closed. The distal two-thirds of the stomach were then removed and the jejunum anastomosed to the open end of the stomach in front of the transverse colon in the usual manner.

This case illustrates the possibility of jejunal ulceration following a Polya operation when only the pylorus is removed. It should be noted that the jejunal ulcer develops subsequent to the jejuno-jejunostomy, an operation which has the obvious drawback of side-tracking the alkaline duodenal contents from the gastrojejunostomy stoma where it is so necessary for the neutralization of the acid secretion from the stomach.

The incidence of jejunal ulcer following stomach operations is certainly greater than was formerly thought. Secondary operations form a very real problem, and although total gastrectomy as a primary operation may be open to criticism, there is no question of its indication in these secondary cases.

DR HOWARD LILIENTHAL called the attention of the society to the frequent results of the removal of a large portion of the stomach with the idea of getting rid of the acid-bearing field. Recently in Philadelphia at a meeting of the American Surgical Association, it was shown that if any gastric mucosa at all is left, acid-bearing tissue will remain.

DR RICHARD LEWISOHN said that the amount of stomach to be resected depends on the size of the stomach. This varies a great deal. The distal half of the stomach should be removed in order to prevent recurrences. In the first case presented, less than one-third of the stomach had been removed, according to the roentgenogram. Therefore, this patient may be subject to a recurrence at a later date. In the second case, pylorotomy had been performed as the primary operation. It is well known that a pylorotomy does not change the acid figures and thus will not safeguard the patient against secondary ulcers.

#### PAPILLARY ADENO-CARCINOMA OF THYROID—CHRONIC STRUMITIS

DR CHARLES GORDON HEYD presented a woman, forty-six years of age, who entered the Post-Graduate Hospital October 26, 1930, complaining of goitre, nervousness and loss of weight. She began to notice an enlargement on either side of the mid-line of the neck about four years ago. For three years there was no appreciable increase in size, but last year it had become noticeably larger. During the past three months the patient has become slightly hoarse. Basal metabolic determinations were 8 per cent above the average normal. October 29, 1930, the patient was operated upon. The right lobe of the thyroid was approximately 6 by 4 by 4 centimetres, densely hard, encapsulated except for a small amount of normal tissue posteriorly. It had remarkable friability but was still definitely within the thyroid capsule, and while the friability and general appearance suggested malignancy, the absence of any perforation of the capsule seemed to render the diagnosis of strumitis possible. The left side was approximately 4 by 4 by 6 centimetres and represented a hypertrophy with generally normal characteristics. The operation was conducted through a typical thyroid exposure.

Section of the masses removed showed small lobules of thyroid gland separated by slightly thickened connective tissue. The lobules were made up of rather small thyroid alveoli, most of them containing well-formed colloid and lined by low cuboidal epithelium. In the stroma between the lobules there were very abundant lymphocytes occurring in numerous dense collections and in some places the bands of fibrous tissue attained a thickness of a millimetre. There had evidently been a definite inflammatory reaction in the stroma.

Microscopic sections of the nodule presented a stroma of dense fibrous tissue in which there were highly irregular groups of thyroid alveoli. Many of these were elongated, branched and partly filled by papillary epithelium. These atypical epithelial cells invaded the fibrous capsule at the margin of the nodule and extended practically to the

## PAPILLARY ADENO-CARCINOMA OF THYROID

more normal thyroid tissue. There were moderately numerous mitotic division figures in the epithelial cells of these atypical thyroid alveoli. In some places there were abundant lymphocytes in the stroma about the alveoli. *Diagnosis*—Papillary adeno-carcinoma.

The patient made an uneventful recovery and was discharged from the hospital on December 5, 1930, and in the interval since the discharge from the hospital has had a course in deep X-ray therapy.

DR MORRIS K. SMITH said that it is disconcerting to remove what is thought to be an adenoma and to receive a pathologic report of carcinoma. He remembered such a case in which, four or five years after operation, no recurrence of the disease was found unless an enlargement of the spleen could be so construed. Another patient reported by the pathologist as having carcinoma developed what was thought to be a local recurrence. She was treated by X-ray and at present, five years and more after the operation, has no sign of malignancy, although she has to take thyroid extract.

DR CHARLES E. FARR said that he had had experience with five cases of carcinoma of the thyroid and had seen one other. His own five patients all died very promptly regardless of operation or radium therapy. Four were proved to be carcinomatous by operation or biopsy. One died without operation but was clinically surely malignant. The sixth case, not his, is still alive but has a recurrence.

DR WILLIAM C. WHITE said that last November he operated on a man for an enlarged thyroid gland and on going down found pale gray material, friable, not vascular, and easily removed. The pathologists disagreed as to the nature of the growth. It was diagnosed by different men as lymphosarcoma, small-cell carcinoma, and Riedel's struma. All thought it was sensitive to irradiation. He was given high voltage Rontgen therapy without improvement. The man died in January with marked recurrence.

DR ALEXIS V. MOSCHCOWITZ said that for many years he had noted that there existed two varieties of carcinoma of the thyroid, one, in which the surgeon makes the diagnosis of carcinoma of the thyroid pre-operatively. These are the cases that do badly, a great many of the patients dying of metastases or local recurrence. In the second group, the surgeon removes the gland or an adenoma, which, upon examination, the pathologist reports as carcinoma. These cases usually do well, a majority of them having no further symptoms from the carcinoma.

DOCTOR HEYD, closing the discussion, expressed the opinion that the goitre patient he had presented would have recurrence. He was quite in accord with Doctor Moschcowitz that there was a great deal of clinical difference between the patient with a goitre who had a pre-operative diagnosis of malignancy and the patient with a goitre who had a histologic diagnosis of malignancy after operation. The former patients did badly whereas the latter did well. It was also well to bear in mind that there is another type

of malignancy which springs from the ultimo-bronchial body which is highly malignant and which at operation exhibits a growth behind the carotid artery. This anatomic relationship does not exist in malignancies that spring from adenoma.

#### ADENO-CARCINOMA OF THE RECTO-VAGINAL SEPTUM

DOCTOR HEYD presented a woman, fifty-five years of age, who entered the Woman's Hospital August 5, 1929, complaining of bleeding from the vagina of three weeks' duration. Examination revealed a recto-vaginal fistula 1 centimetre in diameter, with a cauliflower growth extending from the primary site in the rectum into the vagina. She had had bleeding from the rectum for the previous six months, supposed to be due to hemorrhoids. Three weeks previous to admission she noticed a thin, watery, odorless discharge from the vagina and then some bright red blood. A vaginal examination revealed a malignant process at the junction of upper and middle third of recto-vaginal septum with an indurated sloughing mass 4 centimetres in diameter, the mass sloughing both inside the rectum and inside the vagina. The Wassermann reaction was negative. Under gas anaesthesia a biopsy was performed with the histologic diagnosis of papillary adenocarcinoma. August 16, 1929, under anaesthesia, six needles, each containing 12 milligrams of radium, were inserted into the mass. The patient was discharged from the hospital on August 23 and readmitted February 3, 1930. Since her discharge from the hospital the patient had experienced increasing difficulty in moving her bowels. Rectal examination at this time showed considerable induration on both sides of the rectum. February 11, 1930, five needles, each containing approximately 12 milligrams of radium were inserted into the posterior vaginal wall 1 centimetre apart, one in the midline and two laterally on either side, and a tube of 1012 milligrams of radium was inserted into the rectum through a proctoscope so as to rest in the centre of the annular carcinoma. In addition, during this time the patient received 8 deep X-ray treatments. March 7, 1930, a permanent colostomy was performed by Dr. George Gray Ward, using the Sistrunk technic. The patient was discharged from the hospital April 25, 1930, with colostomy functioning perfectly and with some shrinking of the tumor.

She was readmitted June 23, 1930, and a modified Kraske operation with resection of the entire posterior wall of the vagina was performed by Doctor Heyd July 2, 1930. The gut was freely mobilized and resected *en masse* at about the junction of the recto-sigmoid and rectum, removing thereby the rectum proper and the anus and both sphincters intact. The lower end of the sigmoid was inverted by three rows of sutures and reinforced by interrupted sutures of linen. The peritoneal cavity was sponged dry and hermetically sealed with running suture of No. 2 chromic catgut. Following this a posterior vaginal wall was constructed by suturing the divided vaginal flaps. A self-retaining catheter was placed in the bladder and a small strip of iodoform gauze in the vagina. After the reconstruction of the vaginal wall the peritoneal body was reconstructed by the apposition of the levator ani beneath the posterior commissure, following which a considerable portion of the anatomic hiatus was obliterated by approximating the loose tissues and the wound closed with interrupted silkworm sutures. Anaesthesia consisted of 6 gram of sodium amytal, intravenously, narcosis produced in four minutes, plus spinal anaesthesia. Drainage consisted of the following: (1) Self-retaining catheter in the bladder, (2) iodoform strip in the vagina,

## MELANO-CARCINOMA OF THE RECTUM

(3) cigarette diam in the area of the perineum, (4) two strips of rubber tissue and one iodoform gauze pack in the hollow of the sacrum

The specimen from the Kiaske operation consisted of the rectum, which measured 16 centimetres in length. The anus, perineum and lower part of the posterior vaginal wall appeared normal. At the upper end of the vaginal wall a fistulous opening 3.5 centimetres in diameter, with sloughing, rigid edges, led into the rectum. The specimen was opened after fixation. The rectum from the external to the internal sphincter seemed to be intact. The internal sphincter was considerably bulged toward the lumen, apparently due to carcinomatous infiltration. The ampulla recti was mostly occupied by a carcinomatous mass by projection from the lateral portions of the rectal tube, anteriorly leaving a narrow channel between the posterior wall of the rectum and a wide "V"-shaped space between the anterior rectal wall and posterior vaginal wall respectively. The area of the fistulous opening had a diameter of 2.5 centimetres posteriorly. The rectal wall seemed to be well preserved above and below the fistula.

Microscopic examination showed a typical adeno-carcinoma of primary alveolar, secondary solid type. It invaded in large plump clusters and extended into distant tissues by a diffuse dissemination of single cells or short cell rows. The region of the anus was likewise occupied by the carcinoma. Here it propagated by large atypical cells diffusely along the tissue spaces up to an area which was close to the normal squamous surface epithelium. The glandular structures were irregular, with multiple central necrosis. The epithelial rows were stratified, the cell outlines were indefinite. The stroma between the carcinomatous structures showed only moderate inflammatory reaction. A large number of eosinophilic cells were found among the cells of inflammation. Final pathologic diagnosis was adeno-carcinoma of the rectum, extending into the vagina rectovaginal fistula.

The patient had a very stormy convalescence. Owing to the short distal loop below the colostomy, there was leakage through the posterior sacral wound with considerable loss of substance from sloughing, which was unusually slow in granulating in.

For a considerable period of time the patient made no general systemic headway, requiring a series of transfusions to bring back tissue tone and recuperative power. She slowly gained in weight and was discharged from the hospital October 6, 1930. From this time she has uninterruptedly improved with a gain in weight and strength and is able to function at her housework. She has a normal acting colostomy but has still a small persistent sinus in the posterior median raphe.

## MELANO-CARCINOMA OF RECTUM

DOCTOR HEYD presented a woman, fifty-four years of age, who entered the Woman's Hospital June 10, 1930, complaining of rectal bleeding for the previous three years. She has had no pain but slight rectal burning. She has passed bright and dark red blood at various times. At biopsy on June 11, 1930, a carcinomatous nodule the size of a walnut was found arising from the right side of the rectum, 5 centimetres from the anal margin. The specimen was removed with radio knife. Six radium needles, each containing approximately 12 milligrams of radium, were implanted into the base of the tumor for twenty hours.

The biopsy mass consisted of two portions, one was composed of a solid tumor mass which appeared to be a broad compact layer of tumor cells. The protoplasm is transparent and slightly eosinophilic. There are numerous mitotic figures. Scattered throughout the mass are pigmented cells of very large size and irregular shape, bloated with coarse, mostly round particles of pigment which do not give a positive iron reaction.

The pigment was dark brown, almost black. The destruction of the melanophores was densest at the base of the papillæ. In some areas there were destruction and necrosis. The chromatophores appeared in dense aggregations, being the only remainders of the papillary structure. The other portion of the mass consisted of the same type of tumor cells but the papillary arrangements could not be detected, the cells being in compact masses. Two small glandular structures of the intestinal type were found imbedded in the alien cells, within a short distance from each other. Close to this area was a third stretch of inflamed intestinal mucosa. Invasion of the blood-vessels could not be detected. The histologic diagnosis was carcinomatous melanoma of the rectum.

Following the biopsy and radiation the patient was discharged from the hospital June 19, and was readmitted October 8, 1930. A permanent colostomy after the Sistrunk technic was performed by Dr. George Gray Ward October 10, 1930. Four weeks later a modified Kraske operation with resection of the posterior vaginal wall was performed by Doctor Heyd, November 13, 1930. The growth extended in a linear direction from the anal margin approximately two and a half to three inches upward, but there were evidences of glandular deposits at this area.

A radical excision *en masse* was made. The entire rectum, anus, and posterior vaginal wall were removed *en masse*. There was some slight soiling of the field owing to the perforation of the perirectal tissues, as above indicated. With the tumor mass and upper rectum removed, the lower end of the sigmoid was closed. The stump of the bowel was left free in the operative hiatus. The peritoneal cavity closed intact and completely with No. 2 chromic catgut sutures. The posterior vaginal wall was reconstructed with interrupted sutures of No. 2 chromic catgut and a new perineal body created with three interrupted silkworm sutures. The lower portion of the levator ani was brought together beneath the posterior vaginal wall, the skin wound being closed completely with silkworm suture, except at a point opposite the normal position of the coccyx, which was used for drainage.

This patient made an uneventful recovery and was discharged from the hospital December 31, 1930. Since leaving the hospital she has gained in weight. Her colostomy functions adequately. She has enjoyed comparatively normal health since her operation.

DOCTOR HEYD, in presenting these two cases of resection of the rectum, called attention in the first case to the marked invasion of both the vagina and rectum, with a large rectovaginal fistula, and in the second case to the unusual type of malignancy—a carcinomatous melanoma, or melano-carcinoma. The biopsy performed by Doctor Ward removed practically the entire melanotic tumor as was evidenced in the gross specimen presented. The section of the mass removed after operation showed a gradual extinction of the melanotic characters. Furthermore, it is to be noted that both of these cases were treated intensively with radium needles and by tube radiation together with deep X-ray therapy. In both cases the entire posterior vaginal wall was resected *en masse* with the tumor, necessitating the reconstruction of the posterior vaginal wall. This, technically, was not a matter of difficulty and the final result immediately after operation was not unlike that obtained after a perineorrhaphy. Both cases showed perirectal infection, which undoubtedly was a marked factor in the first case and to a less extent in the second case, in the prolonged wound convalescence.

DR. HOWARD LILIENTHAL said that he understood that both these patients have a functioning colostomy. He referred to two women whom he presented before this society some time ago, one of whom had had an ordinary carcinoma of the rectum, and in the other a carcinoma involving part of the vagina. He had been able in operating on each case to draw down enough

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bowel to implant it in the anal region so each patient, by twisting axially (Gersuny's procedure) has good control and they were saved the annoyance and discomfort of a colostomy. Doctor Lilienthal said he mentioned this at this time because so many things are forgotten as time goes on. Every now and then one sees a case of inoperable carcinoma of the rectum that gets well with radium therapy. This did not mean that radium should be substituted for surgery but it should be remembered in cases which were inoperable. He referred in particular to a case of a man with diabetes who came to him with carcinoma of the rectum which had invaded the posterior wall of the bladder. Doctor Lilienthal proposed establishing a colostomy but the patient objected and was sent to Dr. Douglas Quick, who took a specimen which was examined by Ewing, who confirmed the diagnosis. This man got entirely well under radium therapy. There was no metastasis and he remained well for six or seven years and died with a different disease. The end justifies the means. Doctor Lilienthal mentioned this as presenting one ray of hope on an otherwise hopeless situation.

### CARCINOMA OF THE TRANSVERSE COLON—RESECTION OF TRANSVERSE COLON AND SMALL INTESTINE, SEVEN YEARS POST-OPERATIVE

DOCTOR HEYD presented a man, aged fifty-nine years, who entered the Post-Graduate Hospital February 3, 1924, complaining of indigestion. For the previous two years he had suffered from crampy pain in the right upper quadrant, coming on three to four hours after meals, and accompanied by nausea and vomiting. He was usually relieved of his pain by vomiting or by the belching of gas. His history was otherwise unimportant. There was tenderness slightly to the right of the median line. Gastro-intestinal X-ray examination showed an infiltrated lesion at the mid-point of the transverse colon. February 4, 1924, he was operated upon. At the median point of the transverse colon was an annular carcinoma which obstructed the lumen of the bowel to a degree of approximately 90 per cent. On the anterior surface there was a leakage or perforation with adhesions of the ileum and infiltration into the wall of the ileum. There was considerable inflammatory reaction in both the ileum and in the transverse colon. The small intestine in the region of the cæcum was bound to the anterior abdominal wall as the result of former appendectomy. The gall-bladder was chronically diseased and thickened, and had lost its color, but was without calculi. The stomach and duodenum were apparently clear. No abdominal metastases. No liver metastases. There might possibly have been metastases along the border of the pancreas but these were not palpable on account of the mesenteric fat. An atypical resection of the transverse colon and attached small intestine was done. Gastro-colonic omentum was divided, as was the mesocolon, and the tumor mass mobilized. This involved a resection of the mid-portion of the transverse colon about six and a half to seven inches in extent and a resection of nine inches of the small intestine where the growth had encroached and grown into the small intestine. The operation was technically difficult on account of the former adhesions and the loose, friable fat. The small intestinal ends were united in typical end-to-end anastomosis two-layer technic. The same technic was employed for anastomosis of the transverse colon but had to be modified somewhat on account of the narrow



lumen of the distal portion of the transverse colon. The gall-bladder was left undisturbed. The adhesions were left undisturbed. Three strips of rubber tissue, one to the area of Morrison's space, and two perforating the omentum and carried down into the neighborhood of colonic anastomosis. The omentum was placed between the colon anastomosis and the small intestinal anastomosis.

The pathologic specimen comprised one loop of large intestine to which a loop of small intestine was adherent near the *tænia*. The large intestine was 110 millimetres long and the loop of small intestine 120 millimetres long. The lumen of the large intestine was markedly narrow so far that only a forceps could be passed. The mucous membrane in the area of the narrowing was transformed into a fungoid mass and the entire wall of the intestine was infiltrated by a friable yellow mass. The lumen of the small intestine was wide open. The mucous membrane was regular but there was one nodule which projected into the lumen which was covered by mucous membrane.

Microscopic section showed one specimen of large intestine. The superficial areas were composed of irregular large glands which were lined by cylindrical epithelial cells which showed marked variability in size and shape and frequent mitotic figures. The stroma between the glands showed round-cell and leucocytic infiltration. These glandular structures diffusely infiltrated the entire wall of the intestine and were found near the serous surface. There were large areas of necrosis and the wall showed infiltration by lymphocytes, leucocytes and large wandering cells. A second piece showed mucous membrane of the small intestine with villi. The wall of the small intestine was infiltrated by the glandular structures as described above which penetrated through the entire structures and were found very near the epithelial surface. *Diagnosis*—Adenocarcinoma of the large intestine infiltrating a loop of small intestine.

The patient was discharged from the hospital March 3, 1924, with wound entirely healed and general condition excellent. From the time of his discharge he has enjoyed uninterrupted good health, has gained some 30 pounds in weight. Three years after operation he had a complete X-ray examination of the gastro-intestinal tract which was reported negative. He has remained in perfect health from the time of his discharge from the hospital and in the succeeding seven years there has been nothing to suspect he has had any recurrence of his former trouble.

## CHRONIC CYSTIC MASTITIS, ITS RELATIONSHIP TO CANCER

DR OTTO PICKHARDT read a paper with the above title.

DR GEO L. ROHDENBURG said that Doctor Pickhardt had demonstrated that in chronic cystic mastitis the histologic appearance does not always go hand in hand with the clinical course of the disease. The pathologist recognizes a normal architecture of the breast, in cancer he sees a disordered architecture. Under the microscope chronic cystic mastitis morphologically stands in the mid-position, and having seen the last stages as cancer, the histologist becomes suspicious of the architectural arrangement and calls it pre-cancerous. Unfortunately, the histologist cannot say what the biology of these cells is going to be. A similar condition exists with what are known as "carcinoids" of the appendix. It was a considerable time before it was recognized that these lesions were usually clinically benign. Experimentally, analogous degrees of proliferation have been produced by Schlarch "R," and these have been shown to be clinically benign. With coal tar, the histologic appearance is much the same, but the clinical course is vastly different.

## CHRONIC CYSTIC MASTITIS, ITS RELATIONSHIP TO CANCER

DR HOWARD LILIENTHAL believed that sometime the day would arrive when the term "pre-cancerous" will no longer be used any more than the expression "threatened with typhoid fever" is now being used. The patient has cancer or does not have it. If in doubt, operate as if it were cancer, if there is no doubt and if the pathologist says there is no cancer there is nothing to worry about even if he says it is "pre-cancerous." Chronic inflammation or ulceration demands appropriate treatment without making a diagnosis of "pre-cancerous" lesion. There is, indeed, a great deal in the mental relief of these patients. The speaker was certain from experience that sometimes the removal of a specimen in an organ like the breast is unwise and it is better to proceed on the history and clinical findings, the idea being that a breast may show no cancer in the specimen removed and later on another part will show malignant disease. If in doubt, take off the breast.

DR DEWITT STETTEN, on December, 1928, made the statement that in a relatively large material, mainly among private patients, whom he had been able to follow up rather carefully, he had never seen a case treated primarily for chronic cystic mastitis which had become carcinomatous and, since that time, nothing has occurred that would cause him to modify that statement. Doctor Stetten believes that chronic cystic mastitis is a benign condition, and, in spite of the general impression to the contrary, he does not think that there is any etiologic connection between chronic cystic mastitis and carcinoma of the breast. Practically all of his cases were treated by conservative measures—namely, excision of the cystic mass. In his whole series only two simple mastectomies were done, and these both on the same patient. He has never done a radical mastectomy for chronic cystic mastitis. In those cases in which the cyst alone was excised, the microscopic examination of the surrounding breast tissue almost invariably showed further evidence of chronic cystic mastitis. A number of the cases had recurrences of the disease, requiring in many instances two or more operations, but microscopic study never showed malignancy. Doctor Stetten is so convinced of the benignity of chronic cystic mastitis that, even if the pathologist's report is "pre-cancerous," he treats the case conservatively, if the gross appearance of the lesion is not suspicious. Long observations on a number of such cases over periods running up to ten years have as yet failed to show any development of malignancy. Doctor Stetten agrees with Doctor Lilienthal that the term "pre-cancerous" should be discarded from our nomenclature, as a lesion is either cancerous or it is not. While all admit that chronic irritation may be one of the factors in the development of carcinoma, apparently chronic cystic mastitis is not such an irritation. Of course, carcinoma may develop in a breast invaded with chronic cystic mastitis, just as it may develop in a normal breast, but there is no more evidence to prove that chronic cystic mastitis is a "pre-cancerous" lesion than there is to prove that a gastric ulcer predisposes to carcinoma of the stomach. It is quite true that in many cases of carcinoma of the breast, chronic cystic mastitis will also be found, but this is

readily accounted for by the fact that the ages at which the two diseases are prevalent are about the same. Although the lesion is a benign one, definite cysts or nodules should invariably be excised, certainly when they first occur, as a definite diagnosis cannot be made without excision and the patient will only obtain mental relief by the removal of the lesion. In some cases Doctor Stetten has ignored small recurrences if they are typical on physical examination and if the diagnosis has been definitely established by previous excision.

DR ALEXIS V MOSHCOWITZ stated that he agreed that the term "pre-cancerous" does not mean anything. The patient either has a cancer or he has not. If the patient has no cancer, even a simple mastectomy is not indicated. Doctor Moshcowitz sees a great many patients upon whom he makes the diagnosis of a chronic cystic mastitis. It is his habit in these cases to reassure the patient but not to advise any particular treatment.

In doubtful cases, he advises a biopsy by means of a frozen section. If the report shows the presence of a chronic cystic mastitis, he abstains from any further procedure.

STATED MEETING HELD OCTOBER 28, 1931

The President, DR JOHN DOUGLAS, in the Chair

#### SUBMAXILLARY CALCULI

DR RUSSEL H PATTERSON presented five cases as follow

CASE I—A woman aged sixty, was first seen in Bellevue Hospital October 14, 1931, complaining of a lump in her throat near the mouth which had been present for four years. When she eats or chews she has a lump in her neck, which she has always been able to push back into the mouth and have it remain there, but during the last two weeks she has had constant pain with an increase in size of the swelling in the neck. She is a very large, obese woman. She presents a hard, painful swelling one and one-half inches in diameter in the right sublingual region which increases in size on chewing and swallowing. There is a pea-sized calculus felt at the entrance of the right sublingual duct which seems to completely obstruct the duct. X-rays show two calculi about one-half centimetre in diameter in the floor of the mouth in the region of the right sublingual duct.

*Treatment*—With a mouse-tooth forceps a stone was removed from the lingual caruncle. The second stone required a small incision but was easily removed, as it was not more than one centimetre from the lingual caruncle. The anæsthetic consisted of applying 10 per cent cocaine solution to the floor of the mouth. The patient is now rapidly recovering.

CASE II—A woman, aged thirty-eight, first seen April 12, 1930, complains of intermittent pain and swelling of the right side of the floor of the mouth over a period of several weeks. There is a definite swelling about the size of a hickory nut in the region of the right submaxillary gland. X-rays showed a shadow approximately three by six millimetres and with the long axis perpendicular. This shadow is about two centimetres anterior to the angle of the mandible.

On April 15, 1930, patient under general anæsthesia, an incision was made in the back of the floor of the mouth on the right side, and by dissection a stone about the size of an English pea was removed from the substance of the gland. There were several fine pieces of gravel in the immediate vicinity which were also removed. Following the operation the patient had a moderately extensive nonsuppurating inflamma-

## SUBMAXILLARY CALCULI

tion about all the tissues on the right side of the mouth and neck. This slowly subsided over a period of several weeks and the patient has been symptomatically cured since.

CASE III—A man, aged thirty-six, was first seen December 2, 1929, complaining of a lump in the floor of his mouth on the left side. Examination shows a swelling in the region of the left sublingual gland about the size of an English walnut. The duct cannot be probed. There is a thickened ridge along the course of the duct, and about one and one-half inches from the entrance to the duct there is a hard pea-sized mass felt which is thought to be a stone in the duct.

X-rays show a rounded dense area about the size of a small French pea some one and one-half inches posterior to the canine tooth opposite the ramus of the left side of the jaw.

December 4, 1929, under cocaine, an incision was made parallel to the submaxillary duct down to the stone and the stone was enucleated. Convalescence was uneventful and he has had no further symptoms from the condition.

CASE IV—A man, aged thirty, was first seen September 10, 1928, complaining of pain and tenderness in the right side of the floor of the mouth. The right submaxillary duct was bougied and a stone, one-half centimetre in size, followed the bougie out into the mouth. The patient was free of symptoms for one year when he again had pain and tenderness and swelling in the right side of the floor of his mouth. He has had intermittent pain, swelling and soreness of the mouth since.

X-rays taken recently show four calculi in linear antero-posterior arrangement, suggesting calculi either in the right sublingual or submaxillary salivary glands or in their ducts. Thus far none of them have passed. It is evident that an operation will have to be done to cure the patient.

CASE V—A woman, aged fifty, was first seen on October 13, 1931, complaining of pain and swelling in the left side of the floor of the mouth. There is tenderness and a swollen area about the size of a hazel nut in the left side of the floor of the mouth in the region of the left sublingual gland. X-rays show a probable small calculus in this region. The left sublingual duct has had bougies passed in it on two occasions and a click has been felt, but thus far no stone has passed. The swelling in the gland has somewhat subsided. Operation will probably have to be resorted to.

The reporter said that exactly how these stones are formed is not known. They may be formed on foreign bodies, they may have as a nucleus bacteria or waste products from about the mouth. They are thought in some cases to form as a result of mercurialization. They are thought by some to form in patients with an arthritic diathesis or they may be formed by a change in the reaction of the salivary-gland secretion causing a precipitation of salts. They may vary in number and size. Hulke reported a stone weighing sixty-seven grams. They are more common in the ducts than in the glands and are more common in the submaxillary and lingual ducts than in the parotid duct.

X-rays are frequently reported negative for stone but such would not be the case if careful films were taken in the mouth, as a dentist would take a film of a tooth. The inflammation caused by duct obstruction must be differentiated from other infections, tumors and such conditions of the mouth and neck.

Treatment consists of local applications, the passing of bougies in the ducts, and finally surgical intervention.

DR CONDUCT W. CUTLER, JR., remarked upon the frequent incidence of severe cellulitis in the submaxillary region, which would seem to indicate the

desirability of the early removal of these calculi as possible causes. As illustrating this fact he cited the case of a man who presented the picture of acute angina with a board-like swelling of the floor of the mouth. At operation a large stone, three centimetres in diameter, was discovered in the submaxillary gland. This was removed and the patient made a satisfactory recovery, but one year later he presented his doctor with a perfect cast of the submaxillary gland which he had himself removed from his mouth. He subsequently had no difficulty.

DR JOHN DOUGLAS related the case of a man who came to see him with a history of swollen glands in the right side of the neck for over three months which did not subside. Finally an abscess developed which was opened and drained, discharging a moderate amount of pus. But even after that the swelling continued in the floor of the mouth, making it difficult to swallow. The floor of the mouth became œdematous and swallowing became more difficult. A short time after this the patient felt a foreign body that looked like a piece of broom straw completely calcified which was sticking out of the floor of his mouth and which he pulled out. He then remembered that three or four months previously while eating cereal he had felt something stick in the floor of his mouth. Evidently that little piece of wood ran into the salivary duct. After it was removed the swelling completely disappeared.

DOCTOR PATTERSON reported that there was a woman in the wards of Bellevue Hospital who had a temperature of  $104^{\circ}$  as a result of extensive cellulitis of the floor of the mouth. Rontgenograms were negative, but physical examination revealed a stone emerging from the opening of the duct. Upon the removal of this stone simply by forceps pus gushed out and the patient's condition improved very much. Later the patient began to complain again. This time the X-rays revealed a second stone, which was removed. Then all symptoms subsided. These cases must be more common than is generally known for there are only about 400 which have been reported in the literature. At the time of Dr Seward Erdman's paper in 1920 there were about 300 reported cases.

#### BILATERAL CHRONIC PAROTITIS

DR RUSSEL H PATTERSON presented a woman, thirty-four years of age, who was first seen September 15, 1931, complaining of a swelling in the front of the ears for two years. The onset of swelling was more or less insidious. She attributed it to catching cold while swimming. The swelling becomes alternately larger and smaller. First one side is painful and then the other. The left one was very painful a week ago but after a discharge of white-gray material the pain disappeared and the swelling became smaller. Now the right one is swollen and painful.

There is a swelling in the region of both parotids. The left parotid is soft and about twice its normal size. The duct is open and a clear serous fluid can be expressed. The ducts barely admitted a No. 1 Eustachian tube bougie. The right parotid is swollen and tense, about four times normal in size, and only the smallest amount of clear serous fluid can be expressed. No calculi felt. No inflammation of ducts can be demonstrated. She wears a partial

## REPAIR OF DEFECT IN COLON BY TRACTION

plate for upper and lower teeth. The tonsils are adherent and cryptic. In the neck some of the lymph-nodes at the angle of jaw are slightly enlarged. X-rays were negative.

*Treatment*—Heat, massage and astringent mouth wash were ordered. The ducts have been dilated weekly until they now admit a No. 2 Eustachian tube bougie. The patient was told to massage the parotid regions gently every night. She also was advised to sip small amounts of weak lemon juice twice a day.

Other suggestions not yet carried out were: Use of diathermy, autogenous vaccine, use of X-ray therapy. Her condition has somewhat improved.

The case is presented because

(1) Such cases are not frequently seen.

(2) Though the patient attributes the cause of the parotitis to a cold, remarks from the members of this society as to whether such is likely or not are desired.

(3) Would bilateral partial stenosis be the cause, or an aggravating factor in the disease?

DR. WILLY MEYER suggested treating this condition by means of artificial hyperæmia with the help of an elastic neck band. This has resulted in much benefit in acute and in chronic inflammation of the parotid gland. It should be worn for many days, if necessary, ten to eleven hours of the day as well as night. There is hardly another inflamed tissue in the human body that responds as well to hyperæmic treatment as that of this particular gland.

DR. WILLIAM F. CUNNINGHAM said that eight years ago he operated on a woman who had previously been operated on five times for recurrent enlargement of the left parotid gland and discovered and removed a bristle from a tooth brush. The patient has had no further trouble. Another patient, a boy, in Bellevue Hospital, for three years had had chronic enlargement of the right parotid gland which had been incised three times. The diagnosis was thought to be tuberculosis of the preauricular lymph-nodes or actinomycosis. Sections taken were negative for actinomycosis and tuberculosis. The lower two-thirds of the gland was removed and on section multiple cysts were found.

On microscopical examination these cysts were found to be lined by stratified columnar epithelium and the walls contained lymphoid tissue. These factors are indicative that the disturbance was of branchial origin.

## REPAIR OF DEFECT IN COLON BY TRACTION

DR. EUGENE H. POOL presented a man, thirty years of age, who was admitted to the hospital on December 22, 1926, with supposed thrombosis of the mesenteric vein. Onset occurred three days before admission with severe pain in the left flank and vomiting.

He was acutely ill, the abdomen distended. Patient was explored under local anæsthesia through a lower left rectus incision. An enormously distended, gangrenous loop of large bowel filled with gas and old blood presented. About three feet of this bowel were removed. The distal limb of the gangrenous bowel reached down into the pelvis, the proximal was gangrenous almost to attachment at descending colon. Tapes were loosely tied around the limbs

of the projecting intestine flush with skin, rubber dam inserted about each Redundant bowel was cut away Patient had also some turbid fluid in lower abdomen Post-operative course stormy for first week Gas and faeces began to escape from the proximal loop on the third day The distal limb sloughed down to the recto-sigmoid junction and had to be trimmed out from day to day The upper sloughed apparently to the descending colon Barium enema showed about four inches of rectum remaining An attempt was made gradually to approximate the proximal to the distal segment of bowel by traction (Figs 1 and 2)

With this in mind while the wound was wide open and granulation tissue not firm a rectal tube was passed by anus into wound and sutured to upper segment which was loosened by blunt dissection as much as possible without opening into peritoneal cavity The tube was attached to the thigh by a rubber band producing traction

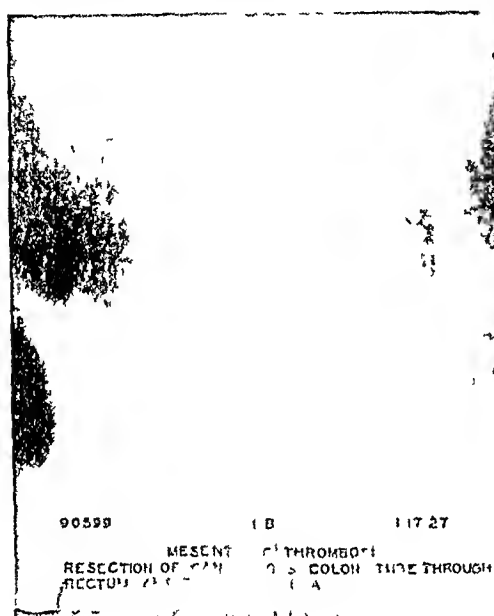


FIG 1



FIG 2

FIG 1—Twenty five days post operative  
FIG 2—Rectum and descending colon in contact Rectum everted Retention above showing stricture between the two loops This was about two months after the original operation

Ultimately by repeatedly doing this the ends were brought close together, bridging the gap which would have been about four inches filled with scar tissue and only to be corrected by some complicated plastic Whether the bowel elongated or was displaced downward by the traction is, of course, a question The procedure was carried out six times, sutures holding up to two days He was discharged with a fecal fistula from a tear in the anterior wall of the bowel Patient had been passing faeces per rectum for some days before discharge May 6, 1927, a right-angled intestinal clamp was applied to an intestinal spur which was obstructing the lumen of the bowel Following this faeces moved more freely by rectum October 7, 1927, colostomy wound was closed and a temporary cecostomy done The closure healed firmly and his faeces passed by rectum Barium enema showed the constriction to be narrow but the barium passed through readily The cecostomy closed automatically April 4, 1929, returned because of acute intestinal obstruction Under local anæsthesia exploration was made and tube inserted



Fig 3—Three years later Dilated upper loop

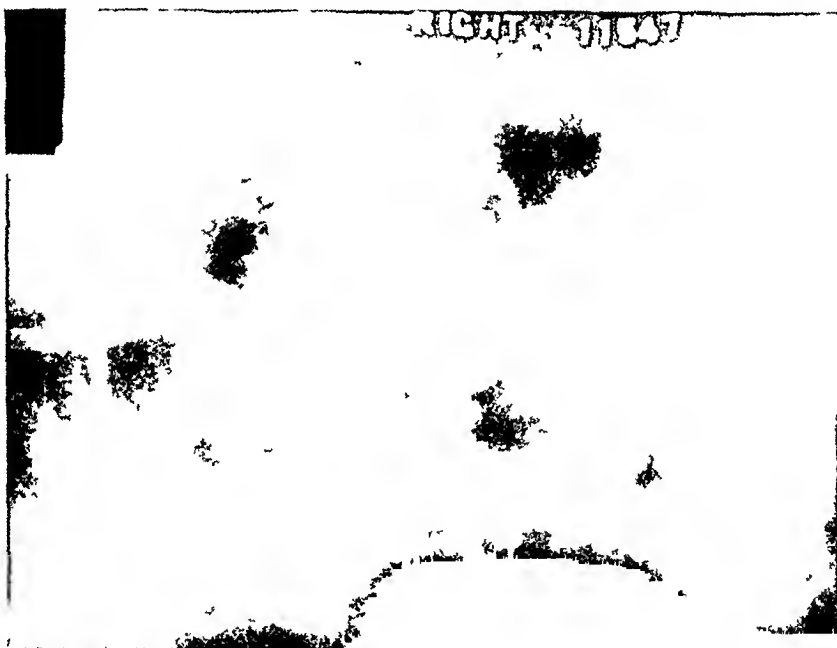


Fig 4—Murphy button in place A sound in rectum



Fig 5—Final result No stricture



into large intestine just above site of obstruction. Convalescence smooth thereafter. Fistula closed spontaneously. November 19, 1930, diagnosis of incisional hernia and stricture of bowel. X-ray showed stricture at point of anastomosis between colon and rectum. Efforts to dilate with bougies were not satisfactory. The proximal loop was enormously dilated and overlapped the rectum. Laparotomy, stricture identified and Murphy button anastomosis done, adhesions freed and ventral hernia repaired. Post-operative course smooth, distension disappeared. Abdominal wound remained firm. He has had no further trouble. (Figs 3, 4 and 5)

This case was presented before the society because it calls attention to a principle which may be of value but has been generally neglected, namely, the potentiality of tissues to elongate or expand under continuous tension. This is seen in the enormous sacs of certain scrotal herniæ and in the elongation and extension of the sigmoid in recurrent volvulus. Numerous other illustrations might be given. It has long been in the mind of the author that

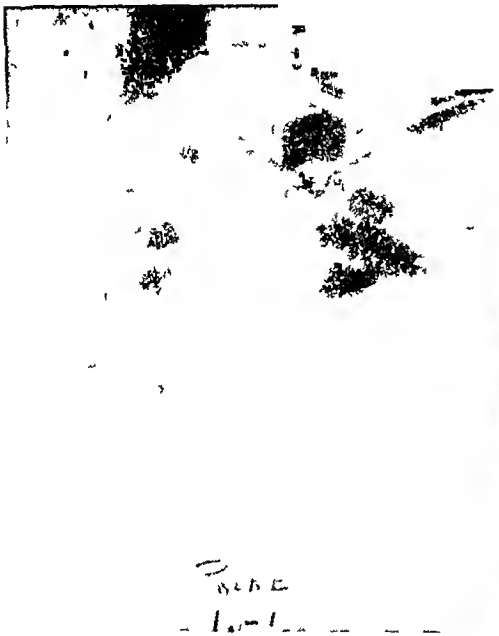


FIG 6—Serous cyst of thorax. Prone



FIG 7—Serous cyst of thorax. Erect

this property of tissues seen in such reaction to pathological conditions might be turned to advantage and deliberately utilized. The effort was made successfully in this case.

#### SEROUS CYST OF THORAX

DR EUGENE H. POOL presented a woman of 56 years who was admitted April, 1931, because of pain in the epigastrium and left flank for four months. The symptoms became marked about two weeks ago with gradual onset of feeling of fullness and heaviness in epigastrium, at times sufficient to affect sleep. The lungs were clear except for a diminished resonance at left base with slightly diminished voice and breath sounds. The heart was not displaced and was normal. Fluoroscopical examination of chest showed on the left immediately above the diaphragm a sharply circumscribed area of increased density of a homogeneous character suggestive of lung tumor.

X-ray of chest showed this mass to vary in position with change in position of the body. In the upright position its upper limit lay at level of fourth

## DIVERTICULUM OF ŒSOPHAGUS TWO-STAGE OPERATION

rib (Fig 7) In the prone position at the level of the second rib It lay in the mesial half of the left thorax in the upright position in front of the heart In the prone position posteriorly (Fig 6) It did not displace the heart There seemed to be an irregularity of the diaphragm as if there were a connection between the thoracic and abdominal cavities Bronchoscopic examination showed a small amount of purulent secretion in the bronchial tree No sign of an intrapulmonary lesion Lipiodol injection showed the mass to be extrapulmonary

Patient was operated upon May 11 Intercostal incision fourth space with division later of fifth costal cartilage Cyst was aspirated and contained 500 cubic centimetres of clear watery fluid Its walls resembled pleura and the cyst lay in the angle between the pericardium and the upper surface of the diaphragm It was attached to both the pericardium and the diaphragm through an area about three inches in diameter Cyst incised and interior explored The main part of cyst wall was entirely excised, but over attached area the



FIG 8—Showing emaciation on admission

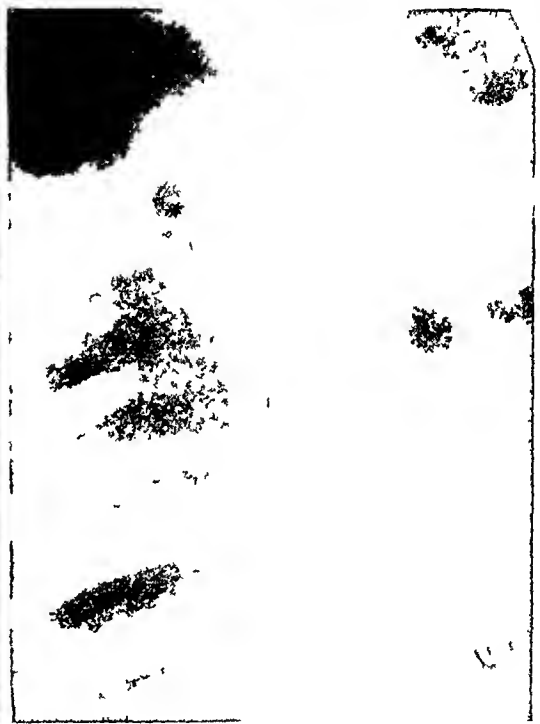


FIG 9—Diverticulum of œsophagus

inner layer only was removed This was readily done by blunt dissection Wall entirely removed by the blunt dissection Section of the cyst wall showed microscopically a loose fibrous structure with apparent covering cells of two to three layers of cuboidal type but nothing specific about the structure The fluid contained a trace of chlorides and a heavy trace of albumin and slightly alkaline to litmus Guaiac test was negative The sediment from a centrifuged specimen contained a few large flat partially degenerated cells with nuclei There were no crystals Since the operation the patient has done well

The case is presented on account of the rarity of such a lesion

## DIVERTICULUM OF ŒSOPHAGUS TWO-STAGE OPERATION

DR EUGENE H POOL presented a man aged sixty-two years, admitted December 2, 1930, for vomiting, which first appeared five years before, and inanition (Fig 8) He had been unable to retain anything during three weeks before admission His best weight was 235 pounds ten years ago, one

year ago weighed 185 pounds, three days before admission weighed 134 pounds

He was a chronically ill looking man showing great loss of weight. There was a bulging in the anterior neck. Diagnosis diverticulum of œsophagus (Fig 9). Because of the malnutrition a gastrostomy was done on December 10, 1930.

Patient gained satisfactorily. Five weeks after the gastrostomy operation for diverticulum performed.

Incision parallel with anterior margin of left sternomastoid muscle. The thyroid gland on the left was exposed and rolled anteriorly and to the right. Stomach tube was passed until it met an obstruction. It was then felt lying in the diverticulum. The diverticulum was then drawn upward and delivered into the incision. A diverticulum of the œsophagus arising about the level of the cricoid process and the postero-lateral surface of the œsophagus and ex-

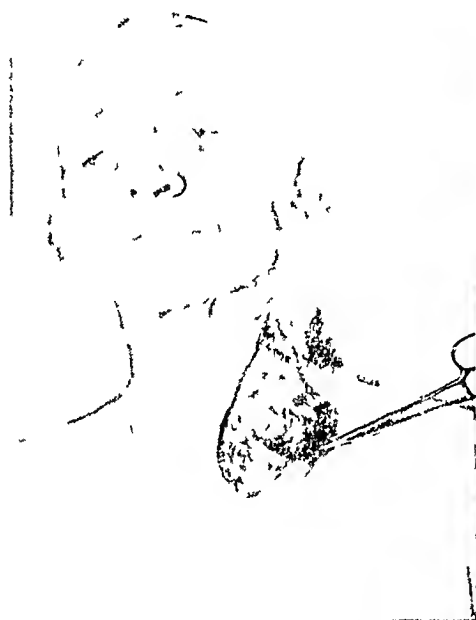


FIG 10—Second stage



FIG 11—Condition three months after operation

tending down into the thorax was found, measured about fifteen by eight centimetres. Walls were thick. The stomach tube was left in this sac and the adherent structures stripped free down to the neck of the sac (Fig 10).

Excision of the diverticulum was done twelve days after this by Lahey's method. The diverticulum was elevated from its bed, its fundus amputated and the mucosa dissected free from the thickened muscularis to 1 centimetre from œsophagus. Packing was inserted into the stump of the amputated diverticulum. Gastrostomy tube withdrawn fifteen days after amputation of diverticulum and sixty-four days after its first insertion. Discharged seventy days after gastrostomy. Both wounds healed rapidly. Weight on admission 134 pounds. Weight April 17, 1931, 183 pounds (Fig 11).

Subsequent note November 14, 1931, No obstruction to bougie. X-ray shows existence of a small diverticulum which empties readily and causes no symptoms. This suggests the advisability of removing the outer wall more completely. This might be done at second stage by tying a heavy silk ligature around the whole sac about one centimetre from œsophagus after freeing and pushing inward the mucous membrane lining of this portion. The sac.

## DIVERTICULUM OF ŒSOPHAGUS TWO-STAGE OPERATION

would slough off beyond the ligature, the end of which would, of course, be left long

DR ALLEN O WHIPPLE said that in cases where the diverticulum is small the procedure of delivering it well outside the neck is difficult. He operated recently on a patient with a small narrow diverticulum, but when the diverticulum was drawn up the top of it could barely be raised above the skin surface. It was anchored to the top of the incision without being opened and the patient was immediately relieved of the difficulty in swallowing. The granulated surface healed over and there has been no trouble since. In some of these cases, once the diverticulum is reversed and anchored in the vertical direction of the food passage, the second-stage operation may not be necessary.

DR FRANZ TOREK said there was a difference of opinion as to the advisability of the one- or the two-stage operation in diverticulum of the œsophagus. Since Charles Mayo advocated the two-stage operation the majority of surgeons have been in favor of it. But on the other hand there are other clinics, such as the Jackson Clinic in Philadelphia, where the one-stage operation is done exclusively and in the speaker's own practice he has always done the one-stage operation. In favor of the two-stage operation the safety against mediastinitis is brought forward, and it is true that in the one-stage method greater care is necessary to avoid infection of the mediastinum at the time of operation and to prevent its occurrence subsequently. The former is accomplished by proper tamponing of the surrounding tissues, the latter by most accurate suturing, with the employment of very fine needles, such as are used in eye surgery.

In the one-stage operation there is the advantage of being able to determine with greater accuracy where the pouch should be cut off to restore the œsophagus to its original shape. Doctor Torek's method is very simple. Two fine guy sutures are introduced, one just above the neck of the pouch, the other below it. As these are held up, an imaginary line drawn from the one to the other indicates the site for the second line of sutures. The pouch is therefore cut off somewhat distal to this line, just far enough to permit the first line of sutures to be inverted. In the two-stage operation it is scarcely possible to estimate the correct site for ablation of the pouch with equal accuracy, unless one again exposes the œsophagus in its entire diameter, the very thing the advocates of the two-stage operation want to avoid. Consequently it may happen that too much is removed and that a constriction will result because the ablation was performed within the limits of the normal œsophagus, or else the difficulty of making an accurate suture in the granulation and scar tissue which has formed since the first stage may cause constriction due to excessive scar contraction at the suture line.

When Doctor Lahey read his paper on the treatment of diverticulum of the œsophagus, in which he advocated the two-stage method, he laid special stress on the necessity of regular bouginage after this operation, which in one case he continued well into the second year. This seems to point to the likelihood of stricture occurring after the two-stage method. In Doctor

Torek's experience with the one-stage method bouginage has not been necessary. He passes the bougie once only, after healing is complete, to assure himself and the patient that the passage is perfect, but never afterward.

Judging from Doctor Pool's roentgenogram bouginage will not be necessary in his case, as there is no narrowing. Here the opposite imperfection has resulted. For a reconstruction of the œsophagus too little has been removed, as the picture still shows the presence of a fair-sized diverticulum. If this happens in the hands of a master surgeon like Doctor Pool, it surely is not due to a lack of surgical skill, the fault should rather be sought in the method.

Lahey reports no mortality in his two-stage operation. On the other hand, in the series of one-stage cases reported by Jackson and Babcock there was likewise no mortality nor was there any in that of the speaker. So it seemed to Doctor Torek that the difficulty of guarding against infection by the two-stage operation is not so serious as reported, and he expressed the belief that the œsophagus can be more perfectly restored by the one-stage than by the two-stage operation.

DR JOHN DOUGLAS said that he had an experience similar to Doctor Whipple's. His patient was an old gentleman who could swallow nothing. An unsuccessful effort was made to introduce a Levine tube and it was suggested doing a gastrostomy to pass the tube from below. It seemed to Doctor Douglas that it would be easier to operate on the diverticulum under local anæsthesia and pull it up as a first stage. As soon as it was pulled up to a position where it did not point downward the patient could swallow and nothing further was done. He lived for several months swallowing easily, but eventually dying of a tuberculous condition. In a poor risk it would seem advisable to confine oneself to this without performing a second-stage operation.

Doctor Pool, in closing the discussion, stated that although Doctor Torek has had astonishing success in doing a number of one-stage operations without cellulitis, it cannot be denied that most surgeons view the one-stage procedure with deep misgivings because they have seen resultant severe cellulitis. The discussion this evening emphasized the question of treating a lesion rather than the patient. There should not be a fixed rule how to treat the œsophagus or any other part of the body, the individual indications should be weighed. This man, sixty-two years of age and starving, could not have stood much surgery nor infection, the fact that he has put on sixty pounds in weight, has returned to work, and is in perfect health is an indication of the success of the two-stage procedure. Whether he has had a perfect mechanical job is immaterial. Whether there is a pouch is likewise immaterial provided the pouch does not cause discomfort. The surgeon's aim should be to get the individual well, and this patient is well.

#### CHORDOMA RADIUM TREATMENT—TEN-YEAR RESULT

DR EUGENE H. POOL presented a woman whom he had presented twice before (cf. *ANNALS*, vol. LXXVI, p. 123, 1922, and *ANNALS*, vol. LXXX, p. 157, 1924). Attention was called to the fact that the tumor is composed of syncytial cells (numerous nuclei but fused cell bodies without cell membranes).

## CONGENITAL CYSTS AND FISTULÆ OF THE NECK

and that it gave the impression of poor vitality which might well be susceptible to irradiation. All reported cases at that time had been fatal, but rarely if ever did they show metastases, the development of the growth being by peripheral extension and infiltration. As nothing has been reported in regard to the late results of irradiation, this case is of interest. It is now over ten years since the treatment which consisted in removing considerable of the sacrum and incomplete removal of the growth which produced within the sacrum a mass about four inches in diameter. Following operation she was treated at intervals for one year with radium at General Memorial. There is no sign of recurrence. The woman is seventy-five years old and decrepit from other causes.

## CONGENITAL CYSTS AND FISTULÆ OF THE NECK

DR HERBERT WILLY MEYER read a paper with the above title for which see page 1.

DR CHARLES E. FARR said that he had had a moderate experience with these cysts of the neck of the congenital type. He once saw a case of bilateral sinuses of the neck with the lower openings just above the clavicles—one so inconspicuous as hardly to be seen except that an occasional drop of fluid appeared.

A week ago he operated upon a large cyst in the right side of the neck where by aspiration and injection of lipiodol an excellent outline of the cyst was obtained. A branch was seen running up to the base of the tonsil and another down the neck to within two inches of the clavicle. On examination of the photograph of this child a dimple could be plainly seen showing where the external opening at one time must have appeared. At operation the cyst was excised without difficulty. It was beneath the sternocleidomastoid muscle lying on the great vessels and the upper portion extending to the base of the tonsil. The lower ended blindly just short of the skin and two inches beneath the clavicle. Recovery was uneventful.

Doctor Farr said it had been his custom for many years in treating mid-line or thyroglossal cyst to remove a large portion of the hyoid bone, leaving a shell if possible. He then cored out the tract widely and deeply to the foramen cæcum. So far as he was able to follow up the cases all of them had remained healed to the present.

DOCTOR MEYER rejoined that he only wanted to add one fact. Branchio-genetic cysts as well as branchio-genetic fistulæ, of course, do occur, but they must lie above the level of the hyoid bone. Anything that lies below the level of the hyoid bone in the opinion of Wenglowski must come from the thymopharyngeal duct.

The idea of resecting the mid-portion of the hyoid bone was not original with the speaker, but he had felt the only way to cure these cases was to resect a portion of the hyoid and dissect the strand of tissue through to the foramen cæcum. The patient must be cured at the time of the first operation or a new cyst may develop if only a few epithelial cells remain. One must do a radical operation in order to surely cure these cases.

# BRIEF COMMUNICATION

## RUPTURED GANGRENOUS CÆCUM

EXTENSIVE inflammation of the wall of the cæcum is rarely met with. One finds references to diverticulitis of this portion of the bowel, but cases of phlegmonous involvement of the wall of the cæcum with abscess formation and rupture are very rare indeed. Search of the literature reveals but few such reports (Bowen,<sup>1</sup> Hagler,<sup>5</sup> Hallopeau and Monod<sup>6</sup>). For this reason, therefore, the following case history is deemed of sufficient interest to place on record by publication.

A white, female child, aged eight years, of good general health, during the night of March 2, 1930, developed pain around the region of the navel, unaccompanied by nausea or vomiting. This pain soon localized itself to the right lower quadrant. It persisted but did not increase when the patient had a bowel movement.

Seven days after the onset of the illness, the child still complained of pain in the abdomen. She was not nauseated nor did she vomit, she was playful in bed, temperature 100.5°, pulse 94. Because of the relative playfulness of the child, because the temperature did not seem to rise more than it had been, and because the symptoms on examination did not become aggravated, it seemed that the acute inflammatory process was subsiding. Patient was still kept in bed on a light diet with icebag applications to the abdomen. Operation was constantly advised but refused.

On the tenth day, and for the first time since the onset of the illness, the child complained of pain on movement of the bowels, was nauseated and vomited. Temperature rose to 102.5°, pulse to 108. Catheterized specimen of the urine showed a faint trace of albumin, 15 pus cells to the field. Blood count 17,400, polymorphonuclears 86 per cent. When seen that evening, there was definite spasm and rigidity of both lower recti muscles, more especially marked over the right, the rebound tenderness was exquisite, the skin was hyperæsthetic over the right lower quadrant, Rovsing's sign was positive. There was no evidence of any mass. Again operation was strongly advised to which the parents finally consented. The operation was performed at the Royal Hospital on March 15, 1930, under open-drop anesthesia. On admission the temperature was 101.6°, pulse 120, respiration 30. A definite mass was visible and palpable in the lower right quadrant of the abdomen, extending from the level of the umbilicus down to the pubis. A median right rectus incision was made. When the peritoneum was opened this mass presented itself. In attempting to free the portions of the intestines forming this mass, a localized abscess cavity was broken into and *B. coli*-smelling pus evacuated. This mass was composed of the transverse colon, a portion of the anterior inferior aspect of the colon being agglutinated to the medial aspect of the cæcum. When separated, it was found that there was a perforation in the medial aspect of the cæcum of 3 fingers' length and about 1½ fingers' breadth within the gangrenous cæcal wall. This opening in the cæcum extended nearly the length of the entire cæcum to just within a half inch of the ileocæcal junction. The anterior and posterior walls of the cæcum were infiltrated so that they were about a quarter of an inch thick, and the whole of the anterior and posterior aspects of the cæcum were gangrenous and the tissue very friable. The appendix was retrocæcal, acutely inflamed, apparently only by contiguity. That portion of the transverse colon which was adherent to the cæcum showed a contiguous gangrenous inflammation eroding the serous and muscular layers down to,

## RUPTURED GANGRENOUS CÆCUM

but not extending through, the internal mucosa for a distance of approximately  $3\frac{1}{2}$  fingers' breadth. Because of the poor condition of the patient, the pulse rate having risen to 148, respirations 60, and because of the extreme friability of the cæcal wall, it seemed best not to attempt any radical procedure. The rent in the external layers of the transverse colon was sutured over with interrupted sutures of catgut. The appendix was then removed. Because of the friability of the cæcal wall it was impossible to close the opening and one wide rubber tube drain was inserted into the cæcal opening, one tube to the pelvis and one to the lateral gutter toward the liver. The patient's immediate post-operative condition was one of severe shock.

For forty-eight hours following the operation, a proctoclysis of 5 per cent glucose and 5 per cent bicarbonate of soda was given by Murphy drip. The patient's pulse gradually dropped to 112, its volume and quality gradually improving. Temperature gradually dropped, so that on the third day it was down to  $101.2^{\circ}$ . The patient passed gas through the rectal tube. The dressings were saturated with purulent and fæcal material. She moved her bowels by rectum either with the aid of small enemata, or naturally. The drainage tubes were removed on the seventh day post-operative. The fæcal discharge continued for nineteen days after the operation. The wound and fæcal fistula were gradually closed over with granulation tissue. Healing was stimulated by the use of alpine light radiation. Seven weeks after the operation the wound was firmly healed, there was no evidence of any herniation.

Re-examination one year later revealed the wound to be still solidly closed, and the patient free of any complaints.

*Comment*—Textbooks on pathology, embryology and physiology have little to say in detail of the adenoid tissue of the intestinal tract and especially the colon. Our works on diseases of the intestine are likewise careless in scientific details. Monographs on appendicitis speak freely of the adenoid tissue of the appendix, yet have no remarks on its analogue, the cæcum. There are abundant evidences that there are infections of the large intestine which have not been very clearly understood. Delafield and Prudden,<sup>2</sup> in their textbooks, refer to a very fatal and obscure form of necrotic colitis which appears to be septic in character. After death the inner surface of the colon is found studded with little blackish areas in which the blood-vessels are gorged with blood. The granular and connective-tissue coats are infiltrated with pus cells and there is a superficial necrosis. Various forms of microorganisms have been found in connection with suppurative and necrotic lesions of the ileum and colon—*streptococcus pyogenes*, *staphylococcus pyogenes aureus*, *bacillus coli communis*, *bacillus proteus*, etc. Ziegler<sup>8</sup> refers to inflammation of the large intestine as sometimes due to septic infection. Piersol<sup>7</sup> writes that the submucous layer of the cæcum, like that of the appendix, is rich in lymphoid tissue, which is readily subject to infection. Dowd<sup>4</sup> wrote that we have long known about inflammation of the large intestine which is known as colitis, which begins primarily in the mucous membrane, leading to a destruction of the parts of the membrane, and which sometimes involves the underlying coats. Through the lymphatics we get infection of this adenoid tissue (or follicular glands) of the cæcum. Irritating intestinal juices may produce erosions and with infection prevailing, these erosions may become ulcerated. If the blood stream is microbic or septic



## BRIEF COMMUNICATION

and the cæcum sensitized, then hæmorrhages or infarcts may ensue, giving rise to a condition which may be known as hæmorrhagic cæcitis

Perforations of the cæcum have occurred in cases of tuberculous or typhoid ulcerations, or cases of stercoral ulcers in patients who have been habitually constipated. Perforations have also occurred as result of foreign bodies which have penetrated this portion of the intestinal tract. Hagler,<sup>5</sup> in reporting his case of dissecting interstitial abscess of the cæcal wall, wrote "It is remarkable that there should have been no adhesions or gangrene, and that the pus should have localized between the layers of the cæcal wall. It is interesting to speculate whether perforation would have occurred into the lumen of the cæcum or into the free peritoneal cavity if operation had been delayed." It is probable that in the case reported herein the patient had an abrasion of the mucosa by fæcal masses, and that an acute phlegmonous inflammation was added to this, just as similar inflammations have existed in the stomach or in the subcutaneous tissues in various parts of the body, and that this inflammatory process terminated in mesenteric thrombosis with resulting gangrene. Of the few cases reported in the literature of gangrene with perforation of the cæcum one finds a case reported by Bowen<sup>1</sup> in a young lady of twenty-seven years who had a perforation of the cæcum near the ileocæcal valve associated with acute appendicitis. Dickinson<sup>3</sup> reported three cases of perforated ulcers of the cæcum, two of which died. Hallopeau and Monod<sup>6</sup> reported a fatal case of massive gangrene of the cæcum. Dowd<sup>4</sup> reported a case of resection of an acute suppurative inflammation of the colon, but this did not involve the cæcum.

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## BOOK REVIEW

DIE CHIRURGIE DER TUBERKULOSE By P CLAIMONT, O WINTERSTEIN and A DIMITZA (Surgical University Clinic, Zurich), 8 vo , pp 661, 392 illustrations Berlin, S Karger, 1931

A most comprehensive work presenting in one volume the surgical treatment of various forms of tuberculosis. As a corollary of their main thesis that a tuberculous lesion almost anywhere in the body may possibly be amenable to such treatment, the authors advocate dropping the term "surgical tuberculosis" with its usual narrow meaning. According to their view, there is no form of tuberculosis which belongs exclusively to the surgeon, nor is the surgeon wholly excluded from any part of the therapeutic domain of this disease. The book passes in review the numerous situations in which surgery may have a part, the text being supplemented by a generous number of excellent illustrations, some of them in color. Most of the recognized clinical forms of tuberculosis receive due attention. Some of the problems mentioned for surgical approach are rarities in practice, but the suggestions at least stimulate thought. In such instances the text sometimes represents merely a citation of literature. The experience of the authors, however, has obviously been wide and constitutes the background of much of their writing, especially in such sections as those on urogenital tuberculosis and tuberculosis of the bones and joints. An exception which will be disappointing to some readers is the section on tuberculosis of the lungs, by far the most frequent form of the disease encountered in actual experience. The advance of chest surgery has been rapid and brilliant in recent years. Collapse and immobilization of the diseased lung by artificial pneumothorax or by one of the more strictly surgical operations such as thoracoplasty is without question the most valuable adjunct of standard rest treatment, and the increasing use of these measures will go far not only to alleviate pulmonary tuberculosis but also to prevent the complications which so often owe their origin to the pulmonary focus. For these reasons the subject warrants more detailed discussion in such a book, although it is perhaps too much to expect that even the collective experience of three men could include so many highly specialized fields.

Great care is evident in the presentation of the modern conception of the pathogenesis and natural evolution of various tuberculous lesions, chief attention being given to the views of the German pathologists who have done such illuminating work in this branch. It is self-evident that no one should attempt to treat a chronic infectious disease like tuberculosis, especially by radical manipulation, unless he can rightfully lay claim to a knowledge of its probable behavior in terms of pathogenetic laws, yet there are some—usually labelled by their impetuosity—who violate this fundamental axiom to the

## BOOK REVIEW

harm of the patient and the discredit of surgery. If the surgeon has not the time or interest to go into this very profoundly he should at least be guided by the counsel of the internist in possession of the information. Happily, in many centres there has sprung up a definite plan of cooperation between surgeons and internists in handling these cases, the consequence being more conservative treatment and better end-results. This book exemplifies the attitude of a clinic where sound comprehension of the pathogenesis and clinical course of tuberculosis dominates therapeutic action—certainly an ideal. One cannot read the paragraphs on tuberculous peritonitis, for instance, without appreciating the refined judgment which guides the authors and without doubting the wisdom of some surgeons in almost routinely advising laparotomy in such cases.

Surgical technic is not discussed in detail. The purpose of the book is evidently to help fill the need of providing a broad understanding of the disease, a requisite condition in successful surgery.

There is a useful chapter outlining methods of demonstrating tubercle bacilli in tissues and fluids and including a discussion of the blood picture and the tuberculin reaction.

A closing chapter is devoted to the Sauerbruch-Hermannsdorfer and the Gerson salt-poor diets, which the authors have tried in 145 cases. They report the diets to be of definite help in tuberculosis of the bones and joints and adjacent soft parts, but feel that diet alone should not be depended upon to the exclusion of heliotherapy, X-ray therapy and general rest treatment.

J BURNS AMBERSON, JR

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# ANNALS *of* SURGERY

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## ACUTE FRACTURES OF THE PELVIS\*

BASED ON EIGHTY-ONE COLLECTED CASES

BY WILLIAM R. GILMOUR, M.D.

OF PHILADELPHIA, PA.

THIS paper is based on eighty-one cases of fractures of the pelvis. They were of various types caused by all sorts of accidents, a motor-driven vehicle being the most frequent offender. Other major causes were severe crushes and falls from considerable heights. The fractures may be tabulated by an anatomical classification as follows:

Fractures of the ilium	20
Superior ramus of the pubis	13
Inferior ramus of the pubis	23
Superior ramus of the ischium	18
Inferior ramus of the ischium	8
Acetabular fractures	8
Separation of the symphysis pubis <sup>1</sup>	9
Definite sacro-iliac separation	7
Isolated fracture of the anterior superior spine	1
Double vertical fracture of the pelvis (Malgaigne)	8
Fracture of the sacrum with associated pelvic fracture	4
Fracture of the coccyx	3

These cases were collected from the ward records of three general hospitals of this city, the Methodist Episcopal, the Northeastern, and the Philadelphia General, for the period from January, 1920 to January, 1929. The ages range from three to seventy-four years with forty of the cases occurring between the thirtieth and fiftieth years. The period of hospitalization averaged three weeks in simple complicated fractures of the ilium and the anterior ring without displacement. The time for the posterior girdle fractures and double vertical fractures averaged seventy days. Cases complicated with a fracture of the femur and visceral injury were hospitalized for periods ranging from five to nine months.

There were in this series twenty females and sixty-one males. Of the eighty-one cases, twenty-three occurred in industrial hazards and fifty-two in automobile and street accidents.

There were seventeen falls varying from a fall of forty-five feet by a steeple-jack, on concrete, to a case of an old lady tripping over a carpet in her home. Severe crushes by machinery, falling walls or heavy objects were found in twelve cases.

Before considering these fractures in classified groups it will be interesting to observe a few points of the bony pelvis, since it is obvious that when

\* Read before the Philadelphia Academy of Surgery, October 5, 1931.

direct trauma is applied to this region the weakest parts are mainly affected. The posterior half of the bony framework of the pelvis is subject to greater stresses and strains imposed upon it by body weight and muscle traction and is consequently much stronger than the anterior half which is comparatively weak. The symphysis pubis, the integrity of which depends mainly upon the sub-pubic and the supra-pubic ligaments cannot be regarded as a strong joint and trauma may cause dislocation of the symphysis instead of fracture of the pubic ramus. Traumatic dislocation of the sacro-iliac joint, on the other hand, in the absence of disease of the joint, is almost unknown. Posterior sacro-iliac ligaments are some of the strongest if not the strongest ligaments found in the human body. Wakeling states further that the acetabulum might be regarded as one of the weak spots in the pelvic girdle, but this is far from being the case. It has been noted that by far the thickest and strongest part of the bone is a bar which extends from the auricular surface to the acetabulum. He compares this bar to a three-sided pyramid, the apex of which is situated at the upper part of the auricular surface, while its enormously thick base supports the upper part of the acetabulum. This thickened bar of bone obviously enables the hip bone to withstand the great stress of body weight transmitted from the sacrum to the head of the femur in an erect posture. A second but less well-marked thickening is noted extending from the tuberosity of the iliac-crest (prominent boss on the fore-part of the iliac crest to which the ilio-tibial band is attached) to the upper part of the acetabulum. If a section is made through the hip bone in a plane corresponding to a line drawn from the upper part of the auricular surface to the acetabulum, it will be seen that the strength of the weight-resisting bar of the bone does not depend alone on the actual thickness of the bone, but also upon a peculiar and remarkable arrangement of the bony material. In the cancellous tissue two sets of pressure lamellæ may be seen diverging from the auricular surface and impinging upon two relatively very thick interjections of the surface compact bone on either side. These interjections are comparable with the *calcar femorale*, upon which the resistance of the inner side of the neck of the femur is so largely dependent. From them spring two sets of the lamellæ, which converge into the upper part of the acetabulum, where again the compact bone is remarkably thick. There are thus two sets of lamellar arches in cancellous bone interposed between the auricular surface and the acetabulum, inverted as regards one another and supported by buttresses of compact tissue. A more adequate arrangement for resisting stress cannot well be imagined. Certain well-known features of pelvic fracture now become intelligible, owing to the resistance which the bases of the two thickened bars of the hip bone confer upon the upper part of the acetabulum.

Fractures of the acetabulum and especially the upper part of the acetabular lip are of relatively infrequent occurrence. In most cases of fracture of the ilium the lines of fracture do not pass downward and forward from the point of application of the trauma, but invariably stop short in the region of the main bony bar.

## FRACTURES OF PELVIS

For purposes of further discussion this group may be classified as fractures of the ilium, fractures of the anterior arch, fracture involving the acetabulum and double vertical fractures. There were twenty cases of fracture of the ilium, of which fifteen were simple fractures. They were all caused by direct trauma which is the definite mechanism for this fracture. Falls accounted for seven cases, street accidents six, while one was due to muscle pull in a child running in a playground. The anterior superior spine was avulsed in this case. In five cases, the iliac fracture was part of a multiple fracture. Three of these cases died, one of streptococcic infection in the pre-vesical space of a case of multiple fracture through the anterior ring of the ilium complicated further by a rupture of the bladder, internal hæmorrhage and dislocation of the femur.

A second case, caught in a cave-in, suffered a double vertical fracture involving the right ilium and spreading through the sacro-iliac joint. The fourth and fifth transverse lateral processes of the spine were also broken. An immediate operation was done to drain an extra-peritoneal rupture of the bladder. Death ensued four hours later. A third case, a male, aged fifty years, fell twenty feet one hour before admission to the hospital, he suffered a double vertical fracture including a portion of the right ilium. The bladder was also ruptured in this case and the skull and ribs were fractured. Death occurred three hours after admission. Treatment of the uncomplicated cases consisted of rest in bed with an appropriate pelvic swathe. An average of three weeks was spent in the hospital and their convalescent period occupied on an average the same period. In the simple cases there were no late symptoms and after a few days no pain or discomfort was experienced except in attempting to turn over. The child, who suffered an avulsion of the anterior-superior spine, made an excellent recovery on conservative treatment.

Forty-six cases suffered anterior ring fractures. The mechanism in these fractures is a compression force applied anterior-posteriorly. The accidents by vehicles numbered thirty-two, crushes seven, and falls also seven. There were nine cases of rupture of the bladder in the entire series, seven fell in this group. The urethra was ruptured on two occasions, marked extravasation of the bladder into the perineum and scrotum was mentioned twice. Thirty times blood per urethram or blood-tinged urine was noted in the history. Three of these six cases of ruptured bladder died, one was unoperated. Ten days after admission perineal swelling was noted in this last-mentioned case and pus was evacuated. The condition became progressively worse and at autopsy a small rent was found in the anterior portion of the bladder near its neck. Two cases made recovery after proper drainage and two died shortly after operation from shock. There was definite displacement of fragments in eighteen cases of this group, the majority of which showed improvement upon reexamination after simple appropriate conservative treatment had been applied. Uncomplicated cases made rather excellent recovery but the convalescent period was a little longer than in the iliac fractures.

There were eight cases of acetabular fracture, three were simple chips, which united perfectly without any pain or displacement. As in Severs' cases, several of these so-called acetabular dislocations have come to the hospital weeks after injury. Cottalorda<sup>4</sup> has experimented on several cadavers, using the force applied through the trochanter. He believes that a fracture of the acetabulum may be produced by a relatively slight blow or fall when applied in the right direction. Our case histories (five cases) are in agreement with this finding. There were no deaths in this group.

The double vertical fractures are the product of the more severe traumatic forces. The degree of dislocation in the pelvis was marked in some of the cases. The cases in this group with sacral involvement were due to severe local violence. Traction on the leg, combined with a pelvic sling, was necessary in several of these patients with the fracture extending through the pubic arch, the sacro-iliac joint and the wing of the ilium, on the same side, with a dislocation upward on that side of the pelvis. There was no peroneal nerve involvement noticed in these cases as described by G. G. Davis. However, some temporary partial weakness was noted in some of these cases for a considerable period of time. The period of hospital stay was the longest in this group for uncomplicated cases. The greatest degree of permanent disability was noted in these last two groups.

*Complications* —Twenty-two cases of this whole series were complicated by fractures in other regions. The shaft of the femur was the commonest site for these associated fractures. One case in this group developed gas gangrene and amputation of the leg was followed by an ultimate recovery. There were nine cases of rupture of the bladder, eight extra-peritoneal and one intra-peritoneal. There were three recoveries in the extra-peritoneal group, and two ruptures in the urethra which were drained and recovered. The perineum was badly lacerated in two cases, with wide tears of the vagina also. There was one case of rupture of the small intestine and one case of rupture of the sigmoid flexure. There were eight deaths in this series. Six died on the day of admission, five of these were operated on for ruptured viscera and internal hæmorrhage. One case died of nephritic complications during the fourth week and one unoperated case died on the eleventh day. At necropsy a small rent was found in the anterior portion of the bladder, near the neck.

The heaviest responsibility in the management of these cases is to truly recognize and treat at the earliest moment effectively, the injuries to the internal viscera. A certain degree of judgment is necessary to determine the presence or absence of a rupture of the bladder and severe injury to the deep urethra, internal hæmorrhage and rent gut. In gross rupture of the bladder intra-peritoneally, the bladder will be empty and nothing will be secured by catheter except possibly blood. In extra-peritoneal ruptures of the bladder, bloody urine is generally present, but within a short time there is apt to be a definite presence of supra-pubic or perineal extravasation of both blood and urine. In those cases in which there is a tear of the deep urethra the passage of a catheter is either difficult or impossible and such instrumenta-

tion should be done with the greatest care as it is possible to do great harm even in minor lacerations of the urethra. If intra-peritoneal rupture of the bladder is suspected, immediate laparotomy should be performed as soon as the condition of the patient will allow and if rupture is discovered, closure by suture should be done followed by intra-peritoneal drainage. If the rupture proves to be extra-peritoneal and in such location as to allow suture, closure is done, but if exposure is difficult, simple drainage of the bladder and prevesical space is sufficient, supplemented by drainage by the urethra. Those cases showing gross lesions of the urethra in men are treated by immediate perineal urethrotomy. If the urethra is completely divided an attempt is made at union, which, however, is not always possible, but if care should be taken, most excellent results can be secured. As simple as these rules are, diagnosis is difficult. Rupture of the bladder, as a whole, is a comparatively rare incidence, but in collected series of fracture of the pelvis, it occurs once in every seven cases.

Campbell<sup>7</sup> in a recent paper studied fifty-five cases of bladder rupture, twenty-one were extra-peritoneal and thirty-four were intra-peritoneal. Ten were not operated upon. Forty-five cases were operated on in this series with a total operative mortality of 55 per cent. The total mortality for the whole group was 63.6 per cent.

The writers in reviews of pelvic fracture repeatedly state that these fractures are not as rare as formerly supposed and that accidents caused by the ever-increasing street traffic are year by year making the fractures more frequent. In 1924 Hirsch<sup>2</sup> stated that fractures of the pelvis constituted from 3 to 1 per cent of all fractures in general. Walker, in discussing Noland's and Conwell's recent paper, stated that 900 fractures were reviewed in the records of the Massachusetts General Hospital for the five-year period 1925 to 1930. There were thirty fractures of the pelvis, which is still 3 per cent incidence. As early as 1908 Ashhurst<sup>1</sup> collected fifty-seven cases of fractures of the pelvis from the records of the Episcopal Hospital in this city for the period from 1895 to 1908. There were eighteen deaths with a mortality of 31.57 per cent. Of these eighteen fatal cases there were no visceral complications in eight, deaths in most of these being due to other injuries (crushes of the extremities, fractured skulls, *etc.*). Ten cases in the group complicated by visceral injury, are listed as follows:

Rupture of the urethra	4 Cases—Recovery, 1, deaths, 3
Extra-peritoneal rupture of the bladder	4 Cases—Recovery, 1, deaths, 3
Rupture of undiscovered portion of the Genito-Urinary Tract	1 Case—Recovery, 0, deaths, 1
Rupture of the liver	1 Case—Recovery, 0, deaths, 1

In 1923, Orator<sup>3</sup> reported the end-results of fractures of the pelvis in seventy cases collected at the Van Eiselberg Clinic of Vienna for the period from 1901 to 1920. There were fourteen deaths, a mortality percentage of 20 per cent. Anterior circular fractures and marginal fractures make up 80 per cent of the total, acetabular 5 per cent, posterior circular Malgaigne



fractures 25 to 30 per cent, in 29 per cent of the cases the results were good and 22 per cent of the results were poor

In 1928, Sever reported fifty-one cases with one death. No mention is made in his text of visceral injury in any of the living cases. He tabulates his results as good in twenty-four cases, poor in ten and unknown in sixteen. This paper has been followed by reviews in the past two years by Wakeley, Culp and Findlay, Harding, Noland and Conwell.

Wakeley<sup>6</sup> in a series of one hundred cases treated by him during the 1913-1928 period found that there were visceral complications in only eleven. The small number of cases in which visceral complications occur is not really so surprising as appears at first sight when it is considered that quite a large proportion—due to their being run-over cases where the pelvis is fractured and multiple visceral injuries are found at autopsy—are immediately fatal. He makes no mention of mortality rate. Culp and Findlay<sup>5</sup> report excellent results in twenty-one of their thirty-five consecutive cases. There were three cases of rupture of the bladder, one with extravasation of urine, rupture of the urethra in two cases, and temporary paralysis of the bladder in one case. Other complications included punctured pleuræ, traumatic pneumothorax, cerebral concussion, ruptured jejunum and general peritonitis. Forty-eight per cent of the cases were complicated by additional fractures in other regions. These complications demonstrate the enormous amount of injury suffered by patients and show the important rôle that fracture of the pelvis plays in traumatic injury. Fatal cases numbered six—17.1 per cent. Harding divides one hundred and twenty-seven cases to a number of groups, placing the greatest number in a general multiple pelvic ring class. There were ten deaths in his series. Five bladder ruptures were encountered with three deaths and one ruptured urethra with recovery. He offers a standardized form of treatment for pelvic fracture in his paper.

Noland and Conwell,<sup>8</sup> in a recent paper, also present a standardized treatment and give results in one hundred and twenty-five acute cases treated in their wards from January, 1920, to July, 1928. Sixty cases showed blood in the urine, twenty-two had sustained rupture of the bladder, nine had either severe laceration or complete division of the deep urethra. There were a total of twenty deaths in this series, a 16 per cent mortality rate. Fourteen, all of whom had severe associated injuries which were regarded as necessarily fatal, died within twenty-four hours following admission.

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## HEMIPELVECTOMY\*

BY KELLOGG SPEED M D

OF CHICAGO, ILL

THIS title may be misleading but is used in place of the more cumbersome description, inter-ilio-abdominal amputation. The two cases here reported included amputation of the leg and were not simply local resection of part or half the pelvic ring.

In surgical experience there is met an occasional instance of extensive disease of the proximal thigh extending toward the pelvis or into the pelvic bones, which if radically removed may promise the patient freedom from further extension and give prolongation of life. In my brief surgical career this condition has been met at least six times and in two of them I have operated for radical removal or inter-ilio-abdominal amputation. Both patients failed to survive. Babcock<sup>5</sup> mentions five inter-ilio-abdominal amputations with three deaths.

The indications are

(1) Extensive disease of the proximal thigh where hip disarticulation will not suffice for complete eradication of the disease. This may be malignant or benign.

(a) Bone tumors involving the proximal end of the femur extending into the soft parts or the pelvic bones or hip-joint and toward the pelvic cavity.

(b) Chronic bone infections in the same locality not yielding to surgical drainage.

(c) Malignant tumors or infections of the soft parts of the hip area extending into the bones of the pelvis or buttock tissues.

(2) Malignant bone tumors of the ilium and tumors of the soft parts of the outer surface of the pelvis extending into the hip-joint and femur or into the soft parts too extensively to yield to local resection of part of the bony pelvis but which require as well removal of the whole limb.

(3) Extensive dissecting aneurisms of the femoral artery.

(4) Crushing injuries of the hip region with gas infections.

Certain rules should be abided by in choosing this radical procedure after the customary complete physical examination of the patient. If the indication is malignant (bone) tumor there must be careful search for regional or distal metastases, especially in the lungs and thorax. The disease should not have penetrated through the iliacus muscle into the pelvis proper nor beyond the boundaries of the sacroiliac and symphysis pubis joints. A thoroughly searching roentgenological examination of the pelvis, femur, lower spine and chest is required to settle these points.

The patient should be at least a reasonable risk for this most extensive

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\* Read before the Western Surgical Association, December 4, 1931

operation and should understand the nature of it so that he is willing to take the chance of loss of life in exchange for the attempt at freedom from the disease or the pain he suffers. Every possible effort at preparation of the patient should be made. Some time may be taken for hyperalimentation. Body fluids should be increased to the maximum, short of cardiac embarrassment or œdema, the heart should be digitalized.

The technic of operation may be briefly given as follows. Differences of incision or even avenue of approach may be required on account of the size or situation of the tumor mass or the abnormal position of the limb from contracture at the hip. After the patient is placed on the table the blood in the limb to be removed may be partly drained back into the general circulation as a means of auto-transfusion by the application of a Martin bandage from ankle to hip, provided there is no real danger of driving in infections or metastases. The patient is placed in the lateral semiprone position lying on the well side, one assistant holding the wrapped limb which is to be removed. The incision starts at the iliac crest a short distance in front of the posterior superior spine of the ilium, passing forward along the iliac crest past the anterior superior spine down along the superior pubic ramus not quite to the symphysis so that the spermatic cord will not be endangered. This incision is deepened rapidly to the ilium, the abdominal muscles are cut free from their insertion at the iliac crest, the edge of the iliacus muscle is rapidly exposed by pushing back the reflected abdominal wall and peritoneum. The superficial and inferior epigastric and circumflex iliac vessels are here encountered, are clamped and tied. The iliacus is then freed from its origin on the inside of the ala of the ilium and is reflected back with the peritoneum and abdominal mass. The dissection rapidly passes forward until the great vessels coming across the pubic spine are encountered. They are exposed, clamped, ligated. Any suspicious lymph-nodes can then be resected as high as is required along the course of the iliac vessels.

The spermatic cord is pushed back and the dissection hugs the pubic ramus until the symphysis is reached. This is easily cut through with a scalpel unless it is completely ossified. By springing the side of the pelvis outward the incision is directed down and backward, keeping well away from scrotum and anus to curve around the thigh at the level required, usually well below the gluteal crease. By cutting off the thigh adductors close to the pubis one may then expose the inferior ramus of the pubis. The psoas muscle with the converging portion of the iliacus is encountered and severed between clamps.

The operator then returns to the site of the start of the incision and extends it downward and backward near the sacroiliac joint, curving down the buttock to meet the anterior angle of the circular incision where it crosses under the upper thigh.

By cutting through the sacroiliac joint the whole half of the pelvis, exclusive of the sacrum, can then be mobilized, and the dissection is carried through the gluteal mass of muscles, picking up vessels as they are encountered. By clinging closely to the ischial ramus the tuberosity may be dissected out almost bloodlessly, the sciatic nerve being encountered, injected and cut off high at this time. The half pelvis and attached leg are thus removed. An ample flap remains. Vessels are tied, any additional removal of pathological tissue follows, and the gluteal flap is then turned upward and inward for attachment first by fascial and muscular suture to the abdominal muscles and then by interrupted skin sutures. A tubal drain may be used.

This method of procedure involves a minimum danger to the peritoneum and bladder both of which are pushed away from the bony structures by rapid dissection. The male patient need not suffer castration because the careful reflecting dissection in no way endangers the scrotum and testis.

## HEMIPELVECTOMY

For fear of spreading the disease or infection, opening the hip-joint seems unwise and would prolong the operation, add to the shock. The major nerves, especially the sciatic, should be injected with novocaine and alcohol before resection.

The two instances of operation here reported have been performed under different anæsthesia. In the first operation straight ether by the open method was used, accompanied by simultaneous intravenous administration of normal salt solution. Cardiac and respiratory stimulants were also given. The second operation was performed under spinal anæsthesia aided by pressor drugs such as ephedrin, digalin, *etc.*, with two ounces of ether by the rebreathing method employed as an adjunct.

The amount of blood loss in the operative field was not startling in either instance. Just how much cannot be stated. The amount of blood lost in the amputated limb was, however, considerable. Great nerve trunk injection



FIG. 1.—First patient just after operation, showing character of flap covering hemipelvectomy stump with novocaine before severance may spare shock. This point could not be decided on after such a small amount of observation. During war service I performed under spinal anæsthesia with no immediate post-operative mortality thirty or more thigh amputations in soldiers suffering from extreme sepsis. Until this case I have not employed this anæsthetic method in civil practice.

CASE I.—A. B., male, fifty-nine years old, admitted to the Cook County Hospital August 3, 1931. No. 1244689. He had been in the hospital before and returned on account of intractable pain for which he was willing to undergo any procedure which might offer relief, even at the possible expense of loss of life. The examination revealed rather a poorly nourished man, evidently in distress from pain in the left side of the pelvis. A hard, fixed tumor mass involving the left ilium extending into the buttock and back toward or into the sacroiliac joint was seen. This tumor did not fluctuate, was not painful to pressure. There was much pain referred along the sciatic distribution for which sedatives were constantly required. In the thigh there was atrophy of disuse. X-ray examination revealed a bone tumor in the ilium with some evidence of bone thickening absorption and new bone formation extending from the acetabulum to the sacroiliac joint. The femur was apparently not involved. The chest showed no X-ray



FIG 3—Post operative X ray of the first patient showing the loss of the pelvic bones from symphysis pubis to sacro iliac joint



FIG 2—X ray film of specimen removed from first patient. The extent of the involvement of the ilium and the hip region by the osteogenic sarcoma is shown along with the surgical separation of the intact pelvis at the pubic and sacro iliac joints

## HEMIPELVECTOMY

abnormality No metastases were clinically demonstrable, and the blood gave a negative Wassermann reaction

Operation for removal of half the pelvis plus the whole leg followed on September 11, 1931 The tumor mass occupied the left gluteal region as far back as the posterior superior iliac spine, swelling out about the size of a grapefruit A preliminary incision into the tumor for biopsy was made It was found to infiltrate into the gluteus maximus muscle, was extremely vascular and apparently bone forming Much hæmorrhage was started up by the biopsy, this was controlled by suturing the wound at once and closing the skin The patient was redraped and put on his right side in the Sims lateral position so that the operation might proceed A report on the frozen section confirmed the diagnosis of osteogenic sarcoma The hemipelvectomy was performed The time of operation including the biopsy was one hour and ten minutes The patient passed away just after the stump was sutured

A post-mortem examination gave the following information (1) Tumor thrombosis of a sacral vein (2) Multiple minute metastases of the pleura of both lungs and parietal pleura on left side (3) Slight hypertrophy of the heart with dilatation of the left ventricle, myocardial degeneration (4) Anæmia of liver and kidneys (5) Atrophy and softening with hemosiderosis of the spleen (6) Diffuse colloid goitre

*Abdominal Cavity*—Bladder 9 centimetres above the symphysis, intact The peritoneum throughout the entire abdominal cavity was intact, pale, smooth and shiny The liver was 15 centimetres below the xiphoid and costal margin Each pleural cavity contained a small amount of clear fluid, and the pericardial sac held about 100 cubic centimetres of the same

The heart weighed 380 grams, was soft and flabby Left valve 18 millimetres, right valve 4 millimetres The myocardium was pale brown and quite friable The left valve was much dilated, and the papillæ were flattened The interior of the aorta was smooth and there were small plaques about the valves The coronary arteries were thinned-walled and had a smooth interior

The lungs were crepitant, distended The pleura was shiny with numerous pinpoint to 5-millimetre, slightly raised and moderately firm grayish plaques In the left lower lobe of the lung was a single pinkish-gray nodule 2 millimetres in diameter Lymph-nodes at the hilum and bifurcation were small and anthracotic A similar group of plaques existed on the diaphragmatic dome, covered by the pleura and extending into the intercostal muscles

The thyroid weighed 60 grams, was diffusely enlarged, uniformly granular, pale purplish-gray

The left half of the pelvis was missing The large veins and arteries of the pelvic region were intact There was very little hæmorrhage around the large defect caused by the removal of the bone Rectum normal, intact On the left side of the sacrum a vein 1 millimetre in diameter presented a lumen filled with soft, pink-grayish nodules as large as 7 by 5 by 3 millimetres There were also pinkish lymph-nodes here up to 20 millimetres in diameter

CASE II—C W, male, forty-five years old, admitted to the Cook County Hospital May 27, 1931 No 1223070 He complains of pain in the left leg but was quite well until early in 1930 when he began to experience constant shooting pain in the left hip and leg down to the heel without known cause Has had a little headache and dizziness and is unable to walk Strength in his left leg, which is atrophic and held in a partly flexed position at the hip, is greatly diminished Deep patellar and other reflexes were normal There was shortening of about 1 inch in the left leg and marked tenderness to motion and palpation at the left hip Here had formed a diffuse, hard, bony mass *evidently involving both femur and ilium* Urine normal, blood Wassermann negative The roentgenological examination showed an irregular area of sclerosis and absorption with some new bone formation in the proximal portion of the left femur extending into

the acetabulum and ilium. There was also a fracture below the neck of the left femur with change of the neck angle and coxa vara. Examination of the chest and lumbar spine showed nothing abnormal. A diagnosis of osteogenic sarcoma of the femur and ilium with pathological fracture of the neck of the femur was made.



FIG. 4—Gross section through the osteogenic sarcoma of first patient, showing involvement of ilium and extension down around hip structures.

Operation was performed October 19, 1931. The technic used was as outlined. Spinal anaesthesia was induced by the injection of 3 cubic centimetres of spinocaine after 3 cubic centimetres of spinal fluid was withdrawn, the operation starting twenty-five minutes later. Two ounces of ether were required to give complete analgesia at the start, no more being used later. The patient was placed on the table with his head down 15 degrees from horizontal and this position was maintained.



FIG. 5—Gross section through the osteogenic sarcoma of the second patient, showing involvement of the ilium, hip joint, and pathological fracture of the subtrochanteric portion of the shaft of the femur.

The blood pressure readings were as follows:

10 20 A M	136/84	before anaesthesia
10 45 A M	134/80	operation began
11 25 A M	126/78	operation ended

Ninety milligrams of ephedrin hydrochloride were given when the spinal anaesthesia was started. At 11 10 A M caffeine sodium benzoate 7.5 grains and digitalin 15 minims were given. At 11 25 A M 15 minims of adrenalin were administered. Hypodermoclysis

## HEMIPELVECTOMY

was administered during the operation so that by 11 55 A M he had received 3,000 cubic centimetres. At this time he was given more caffeine sodium benzoate 15 minims and strychnine sulphate grain 1/30. At 12 50 P M he had adrenalin 20 minims and caffeine sodium benzoate 10 grains but passed away within an hour, the pulse varying between 144 at 11 45 A M and 132 at 12 10 P M, respiration remaining at 40 with no cyanosis. Operative time forty-two minutes. The pathological report of the tumor was osteogenic sarcoma. An autopsy was refused.

The literature on hemipelvectomy is rather meagre, especially on real inter-ilio-abdominal amputation. Billroth in 1891 described such an operation and Jaboulay<sup>4</sup> in 1894 gave a terse description of the technic and indications without mention of the number of patients operated upon. At the German Surgical Congress in 1914 Napalkow<sup>2</sup> said that Von Beigmann was able to collect but thirty-eight instances of pelvic resection, the first being performed in 1885 to which he added an additional case which had a good result with outward rotation of the leg, no amputation of the extremity being done. In 1930 Patel reported a case of removal of a cartilaginous tumor weighing 1,600 grams including part of the pelvis. The patient was able to walk thirty days later. In the discussion of Patel's<sup>3</sup> report DuRand cited a similar case.

König's<sup>1</sup> article cites with his own, other interesting cases operated upon by Kocher 1884, Trendelenburg 1899, and Walzel 1924, for osteochondroma. Most of these patients were able to walk after pelvic resection.

Complete inter-ilio-abdominal amputation, however, seems rare. This extensive and dangerous procedure must be reserved for the extreme case, with an understanding of its feasibility but also of its great mortality. Possibly better methods of combating shock or some combination of anaesthesia may lower the operative mortality and permit surgical relief to be offered to the apparently hopeless situations touched upon in the indications for this amputation.

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# CONGENITAL HYPERTROPHIC PYLORIC STENOSIS IN INFANCY\*

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CONGENITAL hypertrophic pyloric stenosis is one of the most important surgical conditions encountered in early infancy, and, if treated after proper preparation by the Fredet-Rammstedt operation, it can be permanently and easily cured. There are still some who feel that a complete cure can be effected without surgery, but in our hands the various forms of medical treatment such as atropine, thick feeding or refeeding after vomiting have not been successful.

In this study of 119 consecutive cases operated upon by me at the Babies Hospital, I shall endeavor to point out the advantages of surgical treatment and to advocate it in all instances as soon as the diagnosis is established, except in the few mild cases which respond to medical treatment in a week or ten days. Medical treatment, at its best, is uncertain and prolonged for weeks or months under the strictest supervision with expert nursing. This from an economic standpoint, is often impractical, and means prolonged hospitalization of an infant, the disadvantages of which we are all aware. It also means taking the baby from the breast, which is not to be advised. Surgical treatment, on the other hand, is quick, certain, permanent in its results and allows nursing to be resumed a few days after operation.

As shown in this series, pyloric stenosis is much more common in male children, 104 of these 119 patients being boys. It is also interesting that seventy-one patients were first children. Fifteen nationalities were represented, with Hebrew children predominating. Two Negro children were included. It may occur in more than one member of a family, one patient operated upon being the ninth boy of a family of twelve children, the first boy of this family having been operated upon successfully for pyloric stenosis by Doctor Downes. The other seven boys showed no evidence of this condition. The mother made the diagnosis in this case.

The etiology of pyloric stenosis has not been definitely determined, but perhaps the most plausible theory is that of a developmental hyperplasia of the circular muscle of the pyloric ring of congenital origin. In support of this theory is the fact that we have had two seven-months premature infants at the Babies Hospital with well-developed tumors. All authorities agree that the essential feature of the pathology is hypertrophy of the circular muscle of the pylorus. The growth of the circular muscle, which may be so great as to almost completely occlude the lumen of the pylorus, forms the tumor which

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is characteristic of this disease. This tumor is usually about two and one-half centimetres in length, of cartilaginous consistency, stops abruptly at the duodenal end, but merges gradually with the stomach at the gastric end. Because of this almost complete obstruction, the stomach may be four or five times its normal size. It is the spasm of the pylorus accompanying this hypertrophy that causes the symptoms.

The symptoms may date from birth, but this is unusual and makes one think more of a duodenal atresia than pyloric stenosis. The onset of symptoms in this group dated from birth to ten weeks of age. The average age was three weeks. Vomiting, which is always the first symptom, may start abruptly but ordinarily does not. It may follow each feeding and is almost always projectile, the food often being projected several feet. The quantity vomited is small at first but later increases in amount. The vomitus never contains bile, which is an important point in the differentiation of this condition from duodenal atresia. It may, however, contain blood, as it did in four cases of this group. There is always gastric retention, so that the amount vomited at one time may be considerably more than the previous feeding. As a result of this vomiting and loss of nourishment, the patients soon become dehydrated, and, with the rapid loss of weight, they may become emaciated in a comparatively short time. For the same reasons their stools are usually small and dry, and there is a marked decrease in the amount of urine voided.

If the abdomen is watched carefully after a feeding, visible gastric peristaltic waves may be seen in the epigastrium passing from left to right, often in rapid succession. These waves may vary considerably in size and are best seen when the stomach is partially filled. Waves were present in all cases of this series, and, while not pathognomonic of this condition, they are a help in establishing the diagnosis. In addition to the gastric waves, a pyloric tumor may always be felt. It is usually found to the right and above the

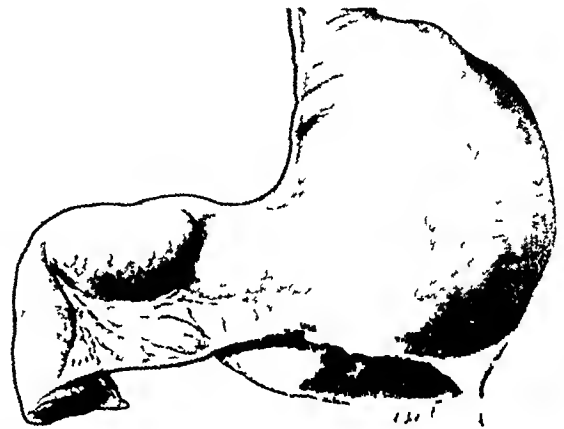


FIG 1

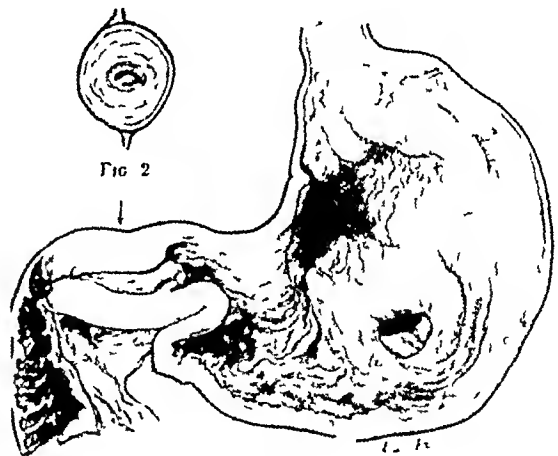


FIG 2

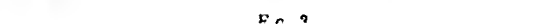


FIG 3

PLATE I—Fig 1—Stomach of a case of pyloric stenosis, showing the pyloric tumor. Fig 2—Cross section of pyloric tumor, showing narrowed lumen. Fig 3—Longitudinal section of pyloric tumor. Note the abrupt change from thick pyloric tumor to thin duodenum.

umbilicus, and, while it varies considerably in size with the contractions of the pylorus, its feeling has been well compared to that of a small olive. Writers disagree on the importance of feeling the tumor, but I believe it is pathognomonic of this condition and may be felt in every case if a painstaking examination of the abdomen is made. It is not always possible to feel the tumor at the first examination as these children are hypertonic and sufficient relaxation of the abdominal muscles may not be obtained at once. A sugar pacifier is generally sufficient to relax the baby after his stomach has been emptied with a small stomach tube. The tumor was felt in every case of this series before operation, but in three of the 119 cases, no tumor was found at operation. Sometimes the lineæ transversæ of the rectus muscle may be mistaken for a tumor if the abdomen is not well relaxed. I have often found it helpful to press the fundus of the stomach gently toward the right with the left hand while palpating for the tumor with the right hand. The tumor is always best felt when the stomach is empty and is very easy to feel in those infants who have lost considerable weight. It has been suggested that light anæsthesia be used for the abdominal examination, but it has not been employed in this series.

Some authors see distinct advantages in using X-ray or fluoroscope to make the diagnosis, even to the extent of differentiating by this method the cases that should be treated by operation from those in which medical treatment should be used. We have purposely avoided this method of diagnosis because we feel that it is possible to make the diagnosis by other means, having always obtained all the information desired, even to measuring the gastric retention without it.

Pre-operative preparation is perhaps the most important factor in lowering the operative mortality in these patients. When this series was begun, it was customary to operate upon the bad cases as emergencies. As a group, they were the poorest possible surgical risks, and the result was a very high mortality. At that time, the mortality from collapse alone was reported in some series as high as 9 per cent. This high mortality is well illustrated by the fact that six of the seven deaths reported in this group of 119 patients occurred in the first nineteen cases operated upon. There has been but one death in the last 100 cases since we have appreciated the value of pre-operative preparation. We now feel that there is no need to hurry operation upon these children even though they are vomiting everything. If the baby is in particularly bad condition, he is given one or two pre-operative transfusions by the Lindemann method, using twenty cubic centimetres of whole blood for each kilogram of body weight. Sixty-eight patients in this series were transfused once before operation, and five patients received two pre-operative transfusions. All patients received from one to four hypodermoclyses of 100 cubic centimetres of 3 per cent glucose before operation. It is amazing how easily you may convert a particularly bad surgical risk into a fair one in two or three days by this means. We have had but one death from collapse, and this occurred very early in the series, before prolonged pre-operative

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treatment was begun. This child, an exceptionally bad risk, died about ten hours after operation, and at autopsy showed nothing wrong with the operation. I am sure that this patient would have been saved under the present régime.

The Friedet-Rammstedt submucous pyloroplasty has been used in every case. It has been found entirely satisfactory and gives a permanent result, as shown by the follow-up. It may be done in about fifteen or twenty minutes, with no attempt made to hurry the operation. Ether by open cone was used in all but three cases, these three being done under novocaine block because of the presence of a respiratory infection. Local anæsthesia is un-

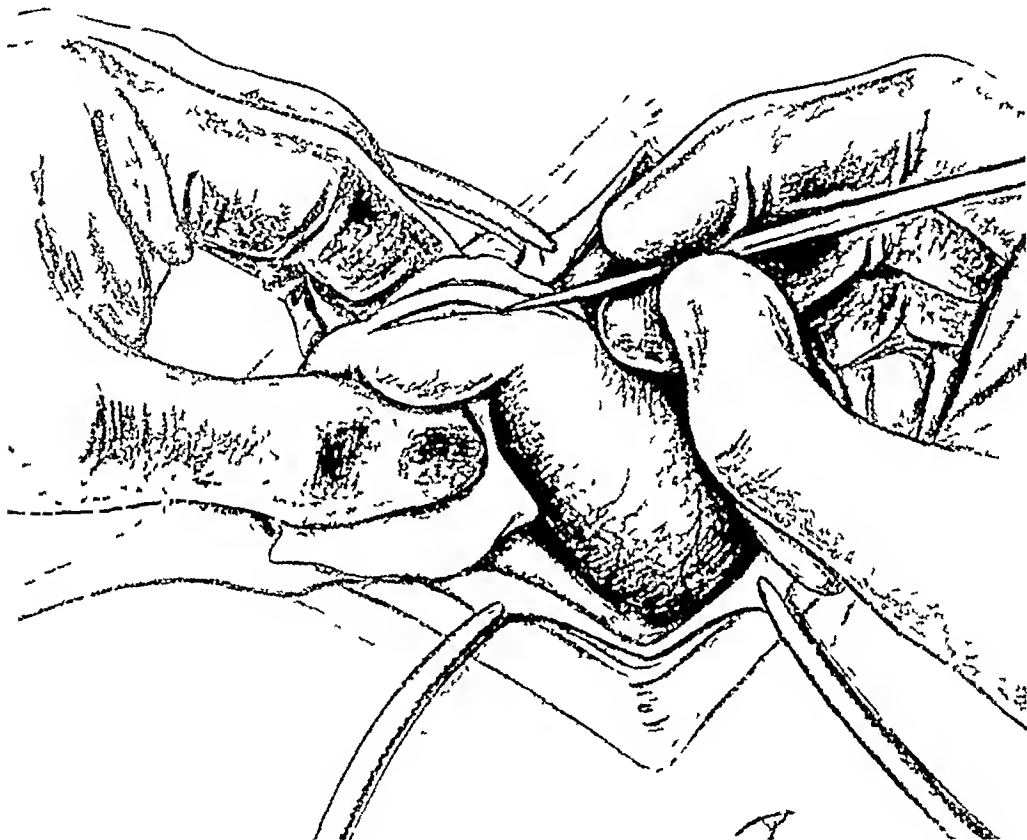


PLATE 2—First step in Friedet-Rammstedt operation. Incision over the entire length of pyloric tumor through the peritoneum and superficial part of circular muscle only.

necessary in the majority of cases, prolongs the operating time and may interfere with wound healing. There has been no case of post-operative respiratory infection in this group. While the operation is mechanically simple there are a few details essential for its success. In order to maintain the body heat during operation, a hot-water bottle is placed under the child on the operating table. Just before the abdominal incision is made, the stomach is emptied by passing a soft rubber catheter, size 18F. The incision used is an upper right rectus about four centimetres long, one centimetre from the mid-line and high enough to completely overlap the right lobe of the liver. This not only makes closure of the abdomen easier but practically insures against post-operative wound rupture. When the abdomen is opened, the right lobe of the liver is retracted upward and the pylorus delivered into the

wound. The tumor is held between the thumb and index finger of the left hand. Beginning at the duodenal end, an incision is made over the entire extent of the tumor in its least vascular part and through the peritoneum and superficial part of the circular muscle only. The cut muscle edges are then separated with a small mosquito forceps until the mucous membrane completely fills the incision. Any bleeding encountered may usually be controlled by application of hot moist pads. If not, the vessel is under-run with fine black silk. In some of the older cases separation of the cut edges may be more difficult and more bleeding may be encountered. If it cannot be stopped by these means a small strip of muscle from the rectus may be

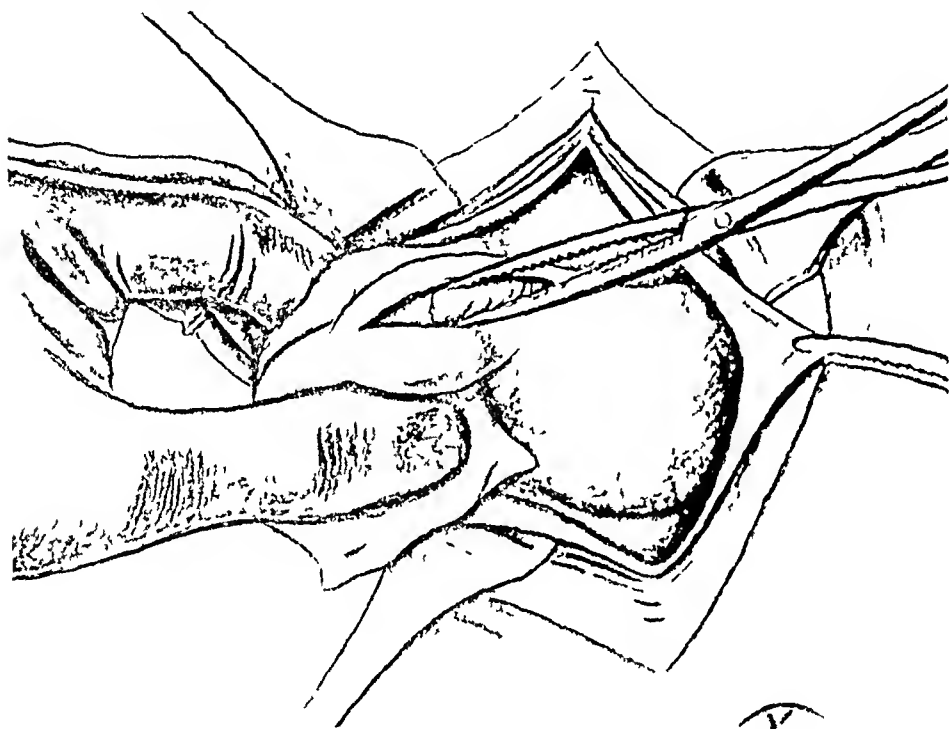


PLATE 3—Second step in Fredet Rammstedt operation. Beginning the separation of cut edges of pyloric tumor

sutured in the pyloric incision. This procedure was necessary in only two cases. It is important to see that all bleeding is stopped before the abdomen is closed because some deaths have been reported from hæmorrhage from pyloric incisions.

After the bleeding is stopped, the pylorus is dropped back and the abdomen closed in layers, using continuous chromic for parietal peritoneum and anterior rectus sheath with Michel clips for the skin. A piece of gauze just large enough to cover the incision is strapped into place with adhesive in order that any bleeding from the incision may be quickly detected. From the operating room the child is taken to a constant-temperature room used exclusively for these cases. The head of the bed is lowered until he recovers from the anæsthetic to prevent aspiration of mucus. Two hours after operation, fifteen cubic centimetres of water are given by mouth, and four hours

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after, the first feeding of four cubic centimetres of breast milk and four cubic centimetres of barley water is given. The breast milk and barley water are increased five to ten cubic centimetres with each three-hour feeding until the child is taken thirty cubic centimetres at the end of forty-eight hours. The breast milk is then increased five to ten cubic centimetres daily until the caloric requirements are met. One or two clyses of 3 per cent glucose are given each day for the first three days. All feedings for the first five days are given with the medicine dropper, and breast-fed babies are allowed to nurse once on the fifth day, twice on the sixth day and so forth until they are completely breast-fed. If the baby is to be discharged on a formula,

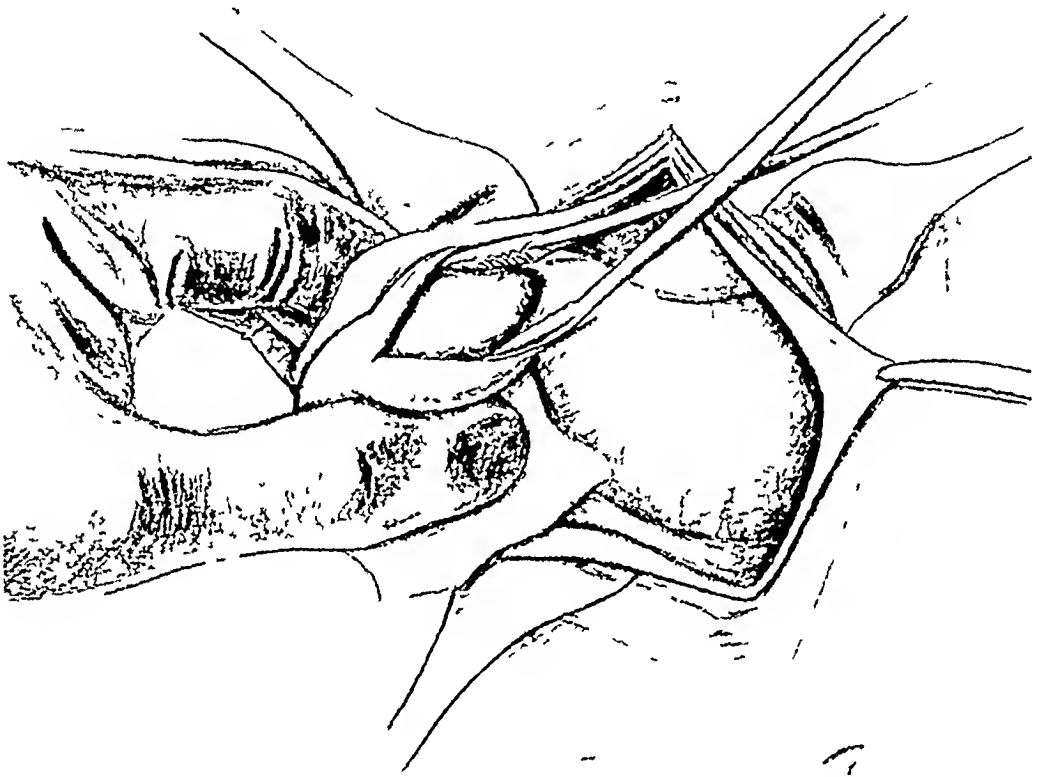


PLATE 4—Third step in Fredet-Rammstedt operation. Completing the separation of cut muscle edges until the mucosa completely fills the incision.

evaporated milk seems to be well tolerated, and, beginning about the seventh day, one formula feeding is substituted for a breast-milk feeding until he is completely on the formula. These children have a low food tolerance because of their long period of starvation, and, therefore, post-operative feeding must be very carefully planned and an effort made to obtain breast milk for all patients for the first five days. With this routine, it is exceptional to have anything but a smooth convalescence, and 90 per cent of these patients showed an appreciable gain in weight before being discharged from the hospital between the tenth and fourteenth days after operation.

The complication most to be dreaded in this operation is accidental opening of the duodenum. The change from thick pyloric tumor to thin duodenum is rather abrupt, and great care must be exercised in separating the cut muscle edges toward the duodenal end. This complication has not occurred

in this series. There has been no bleeding either from the pylorus or the abdominal incision. There have been three gross wound infections but none of them sufficient to materially interfere with convalescence. Wound edges have separated in three cases, and in each case an immediate resuture was done. There have been no post-operative ventral hernias to date.

All patients dying in the hospital have been reported as operative deaths. In this series of 119 cases, there were seven deaths, or a mortality of 5.9 per cent. Six of the seven deaths occurred in the first nineteen cases, one death in the last 100 cases. Two of the seven cases that died did well after operation for three and six days respectively, then became cyanotic and died very suddenly. No autopsies could be obtained. One patient died of shock ten hours after operation. One died of gastroenteritis one month after operation and another died of gastroenteritis fourteen days after operation. One child was reoperated upon through an error in judgment and died twenty-four hours after the second operation. The seventh patient died of inanition and marasmus five days after operation. A more detailed review of the hospital deaths is given below.

CASE I—J. C., 25027, aged ten weeks. Admitted, September 19, 1924. Died, September 24, 1924. History of vomiting since birth. Transfused. Operation, typical Rammstedt. Large tumor. Died that night from weakness and shock. Autopsy showed no evidence of hemorrhage.

CASE II—R. M., 26680, boy, aged two months. Admitted, August 16, 1925. Operation, August 22, 1925. Died, August 28, 1925. Poorly developed, badly nourished, poor general condition. Large tumor. Typical Rammstedt. Baby did well after operation and died very suddenly on the sixth day. Became cyanotic and dyspnoeic. No autopsy.

CASE III—N. I., 27907, boy, aged ten weeks. Admitted, June 18, 1926. History of vomiting for two months. Poorly nourished. Transfused before operation. Operated upon four days after admission. Large tumor. Typical Rammstedt. Child continued to vomit and was not doing well. Explored and no evidence of trouble found. Child did not do well after second operation and died the next day. Autopsy showed nothing wrong with operation. Mistake to operate upon the child the second time.

CASE IV—L. H., 28042, boy, aged thirty-nine days. Admitted, July 9, 1926. Died, August 2, 1926. History of normal labor. Birth weight, seven and one-eighth pounds. Began to vomit in second week. Transfused and operated upon as an emergency. Died about one month later, after typical gastroenteritis, having many loose stools daily. This child apparently had gastroenteritis at time of operation. At any rate he had very bad stools immediately afterward, which persisted for three weeks until death. Bad judgment in operating at this time.

CASE V—A. A., 28543, boy, aged three weeks. Admitted, October 16, 1926, and died, October 23, 1926. Poorly developed, premature, badly nourished, emaciated. Had thrush. Had not gained weight since birth, five and one-half pounds. Operation, typical Rammstedt. Child did very well for three days post-operatively, when he suddenly became cyanotic, dyspnoeic, and died in two hours. Post-mortem abdominal examination showed no hemorrhage and no infection.

CASE VI—C. T., aged seven and one-half weeks. Admitted, October 20, 1926, and operated upon October 22, 1926. Normal birth. Began to vomit at second week, continuing until he was vomiting everything. Typical picture of marasmus. Transfused on day of admission. Operated upon two days later. Typical operation. Very poor risk. Transfused after operation. Condition grew progressively worse, and he died five days

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after operation from marasmus Wound clean Should have had his general condition improved more before operation

CASE VII—J M, aged twenty-one days Admitted, April 3, 1930 Admitted to medical ward four days before operation Transfused before operation, when a large tumor was found Typical Rammstedt Wound broke open on the fifth day, requiring resuture Died on the thirteenth day after operation from gastroenteritis, in spite of two transfusions Only case that has died in the last 100 cases operated upon No autopsy

Ninety-five of the surviving 112 patients have been followed for periods of weeks to four years Seventeen patients were lost to the follow-up Three patients discharged in excellent condition died after leaving the hospital, one from erysipelas thirty days after leaving the hospital His incision was clean, and he was entirely free from gastric symptoms One died two weeks after being discharged from the hospital from sepsis as a result of a streptococcus sore throat His wound was clean, and he was entirely free from gastric symptoms One child died of sepsis ten days after leaving the hospital, the infection in this case being the result of funiculosis His wound was clean and he was entirely free from gastric symptoms The remaining ninety-two patients are alive and well

In view of the fact that we have had but one death in the last 100 cases, I feel that it is safe to predict a mortality of 1 per cent or less for the surgical treatment of this condition If so, there is little to be said in favor of any other form of treatment for pyloric stenosis in infants since surgery can be regarded as safe and entirely satisfactory

### SUMMARY

(1) Analysis of 119 consecutive cases of hypertrophic stenosis operated upon by me at the Babies Hospital

(2) Condition is more common in first children, and boys predominate 7 to 1

(3) Vomiting is always the first symptom, and the average age of onset in this series was three weeks

(4) A pyloric tumor is pathognomonic of the disease and can be felt in every case if a painstaking examination is made

(5) Pre-operative preparation is the most important factor in lowering the mortality as the poorest risk can be converted into a case safe for operation in two or three days

(6) Friedet-Rammstedt submucous pyloroplasty is the operation of choice and was done in all cases

(7) Local anæsthesia is necessary only in the presence of pre-operative respiratory infection It prolongs the operation and may interfere with wound healing

(8) Accidental opening of the duodenum is complication most to be feared in this operation It did not occur in this series

(9) Seven deaths in 119 cases mortality of 5.9 per cent Six of these seven deaths occurred in first nineteen cases operated upon before the value



of pre-operative preparation was appreciated. There was only one death in the last 100 cases operated upon.

(10) Follow-up report on ninety-five of the 112 surviving cases. Three cases died after leaving the hospital from conditions independent of pyloric stenosis. All cases including these were entirely free from gastric symptoms.

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# INFRA-PAPILLARY GASTRODUODENOSTOMY BY MOBILIZATION WITH RETROMESENTERIC DISPLACEMENT OF THE DUODENUM AND JEJUNUM

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ALTHOUGH the etiologic factors concerned in the causation of chronic peptic ulcer in man remain unknown and although the treatment, both medical and surgical, is still empirical, nevertheless there have been constant improvements in the rationale of the operative treatment of this condition, since 1881 when Nicoladoni<sup>1</sup> first devised gastroenterostomy. In the last fifty years many of the world's most renowned surgeons have concerned themselves with the development of various operations, the applicability of which depended primarily upon the anatomic variations of the patient and on the location of the pathologic lesion. These factors must undoubtedly be taken into consideration, but the physiologic effect of an operative procedure upon the stomach and intestine must also be thought of.

In the earlier years of the surgery of the stomach, the technical side of the operation was of major importance, while today one must consider as well the post-operative function of the stomach. As a result of post-operative examinations of patients as well as experimental animals, it has been found, in this clinic, that operations upon the stomach vary considerably in their physiologic effects, judged from the subjective sensations on the part of the patient and the analysis of the stomach contents after the injections of histamine. In brief, operations upon the stomach, in which an anastomosis with the small intestine is performed below or distal to the ampulla of Vater, result in a greater reduction of the acidity of the gastric juice, due to a reflux of duodenal contents, and a more rapid emptying time of the stomach than is the case in operations in which the anastomosis is made above the ampulla of Vater. In the latter type the analysis of the gastric contents reveals a persistent high free and combined acid with a delayed emptying time for the stomach. The object of any surgical procedure upon the stomach and duodenum for a chronic ulcerative lesion must be, first to restore the disturbed function of the stomach as nearly as possible to normal, and second to remove, if possible, the ulcer. It is with these two facts in mind that the operation to be described has been devised and employed.

*Review of Literature*—Gastroduodenostomy was first suggested by Jaboulay<sup>2</sup> in 1892 and performed by him in 1894. This consisted of an anastomosis between the upper portion of the second or descending part of the duodenum with the anterior wall of the stomach. The duodenum was not mobilized, but the stomach drawn over and sutured to it (Fig. 1). Kummell<sup>3</sup> in 1895 divided the duodenum, closing the proximal and implanting the distal end into the anterior wall of the stomach near the greater

curvature (Fig 2) In 1898, Henle<sup>4</sup> reported "Ein Fall von Gastroduodenostomie," in which he had performed a simple subpyloric anastomosis between the anterior wall of the duodenum and the stomach (Fig 3) Carl and Fantino<sup>5</sup> in the same year,

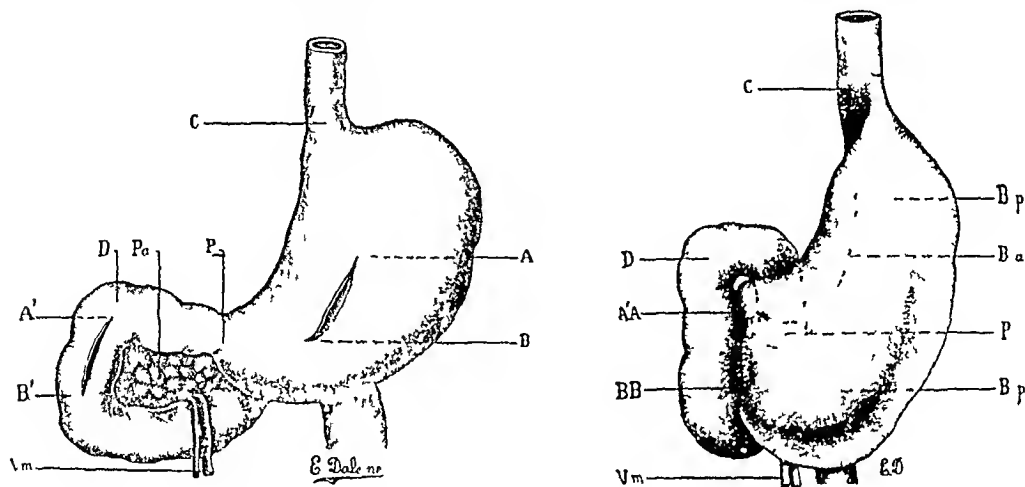


FIG 1—Method of Jiboully

1898, report one case of gastroduodenostomy which like that of Henle,<sup>4</sup> was a simple subpyloric lateral anastomosis between the anterior wall of the stomach and the upper portion of the second or descending part of the duodenum Villard<sup>6</sup> described practically the same operation previously reported by Henle,<sup>4</sup> as well as Carl and Fantino<sup>5</sup>

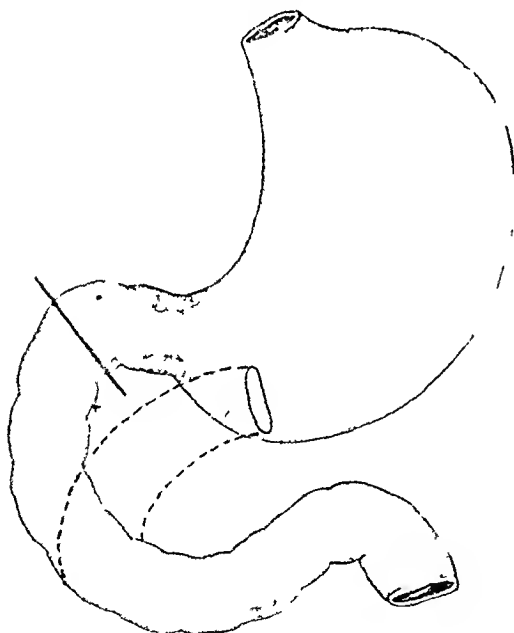


FIG 2—Gastroduodenostomy (Kummell's method)

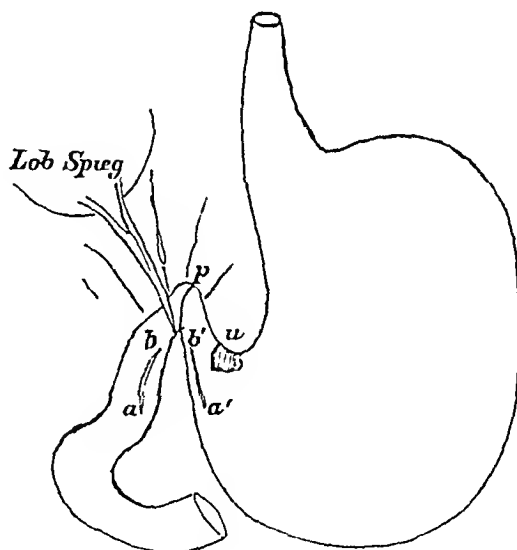


FIG 3—Method of Henle

Villard's<sup>6</sup> "Gastro-Duodenostomie Sous-Pylorique" was published in 1900 No attempt to free the duodenum was made by either Henle,<sup>4</sup> Carl and Fantino,<sup>5</sup> or Villard<sup>6</sup>

In 1901 Finney performed for the first time the operation of pyloroplasty which now bears his name and was the first to methodically free the entire first, or superior portion, and the upper half of the descending portion of the duodenum Five similar cases were reported by him in 1907 He did not use the word mobilize but advised to

## INFRA-PAPILLARY GASTRODUODENOSTOMY

"free as thoroughly as possible" the first twelve centimetres of the duodenum. In 1903 Kocher,<sup>8</sup> probably unaware of Finney's paper, as the latter was published in July 1902 whereas Kocher's appeared in January 1903, published his article on "Mobilisierung des Duodenum und Gastroduodenostomie." He mobilized the entire second or descending portion down to and including the inferior flexure of the duodenum. Kocher's mobilization of the duodenum was continued farther downward than that of Finney. A lateral anastomosis was then performed between the anterior wall of the stomach and the mobile second or descending portion of the duodenum.

In 1915 Moynihan<sup>9</sup> described a form of gastroduodenostomy which he later modified by shifting the incision in the stomach from a vertical one in the anterior wall of the pyloric antrum to one beginning at the pylorus and running parallel to the greater curvature of the stomach (Figs 4 and 5). In 1917 Balfour<sup>10</sup> described a subpyloric anastomosis between the duodenum and stomach just below the pylorus with an inversion of the ulcer, if present on the anterior duodenal wall by two mattress sutures (Fig 6). Balfour, although stating that he prefers gastrojejunostomy, in discussing the circumstances justifying a gastroduodenostomy makes this interesting statement under

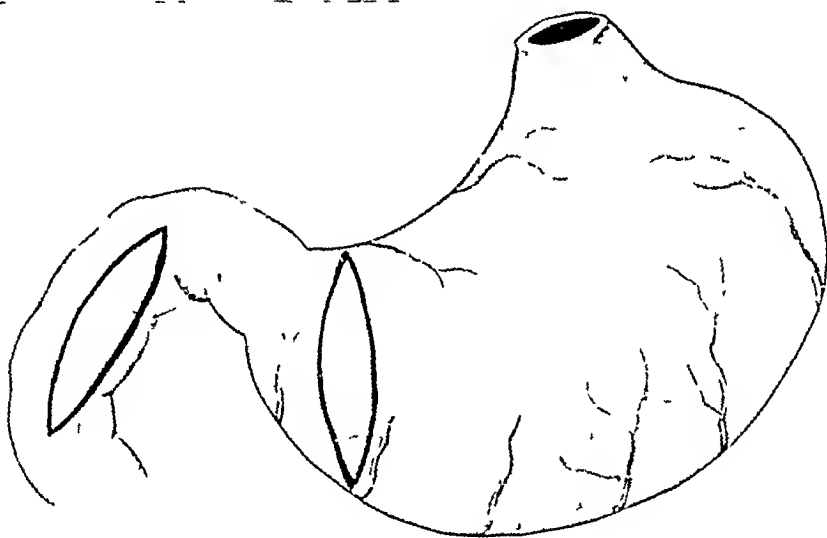


FIG 4.—Gastroduodenostomy showing the parts to be embraced by the clamp. First method of Moynihan (Abdominal Operations, Moynihan W B Saunders Co)

his third indication for gastroduodenostomy "In those instances in which patients have failed to obtain the expected relief from gastrojejunostomy because of secondary complications, such as gastrojejunal ulcer and mechanical difficulties because the operation was ill advised or improperly done, or because of unknown reasons—in such cases gastroduodenostomy has been of signal value following the cutting off of gastrojejunostomy and the restoration of the walls of the stomach and jejunum." It would seem that if gastroduodenostomy were so efficacious a procedure secondarily, it might have been equally successful primarily.

In each of the above references, however, it is to be noted that the gastroduodenostomies were always performed between either the first or upper portion of the second part of the duodenum and the stomach. Also it is evident that mobilization was performed only on the right side and was concerned with only the first and second portions of the duodenum.

In order to facilitate secondary operations upon the stomach following complications after gastrojejunostomy by increasing the length of the short afferent loop of jejunum, Schumacher<sup>11</sup> in 1910 and later Clainmont,<sup>12</sup> in

1918, mobilized the fourth or ascending portion of the duodenum from the root of the mesentery of the jejunum to Treitz' ligament, or the plica duodenalis mesocolica. They then performed a lateral anastomosis between the fourth or ascending portion of the duodenum and the efferent loop of jejunum. Freeing of the terminal portion of the duodenum was suggested by Schumacher and Claimont only in case a secondary operation was necessary after a gastrojejunostomy following the development of an ulcer pepticus jejunum, extensive adhesions, and other post-operative sequelæ. No other references to the use of the fourth or ascending part of the duodenum could be found.

*Operative Technic*—A right rectus incision is made about two centimetres to the right of the mid-line, extending from just below the right



FIG. 5.—Second method of Moynihan. The lines of incision in the stomach and in the mobilized duodenum are shown. (Abdominal Operations, Moynihan W. B. Saunders Co.)

costal margin to the level of the umbilicus (Pl. I, Fig. 1). This incision is curved slightly towards the mid-line in its upper portion, running parallel to the right costal margin for a distance of three centimetres. It is carried down through the skin and subcutaneous tissue through the anterior and posterior sheaths of the rectus muscle, splitting the rectus abdominis along the course of its fibres. The peritoneum is opened exposing the stomach and first or superior horizontal portion of the duodenum. A Mikulicz pad, moistened with warm salt solution is placed upon the transverse colon and omentum so that a gentle pulling inferiorly and downward may be made by an assistant. This places the posterior parietal peritoneum covering the anterior wall of the second or descending portion of the duodenum, on a stretch

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(It is to be recalled that the peritoneal covering of the anterior surface of the transverse mesocolon and the greater omentum fuse along the inferior border of the pyloric antrum, pylorus and inferior border of the first portion of the duodenum continuing down over the anterior surface of the head of the pancreas and the anterior surface of the second or descending portion of the duodenum to become the peritoneal covering of the posterior and lateral wall of the abdomen )

An incision is made through this reflexion of peritoneum just lateral to the right border of the inferior half of the second or descending portion of the duodenum (Pl I, Figs 2 and 3 ) It is then possible to obtain a plane of cleavage between the original posterior peritoneal lining of the abdominal

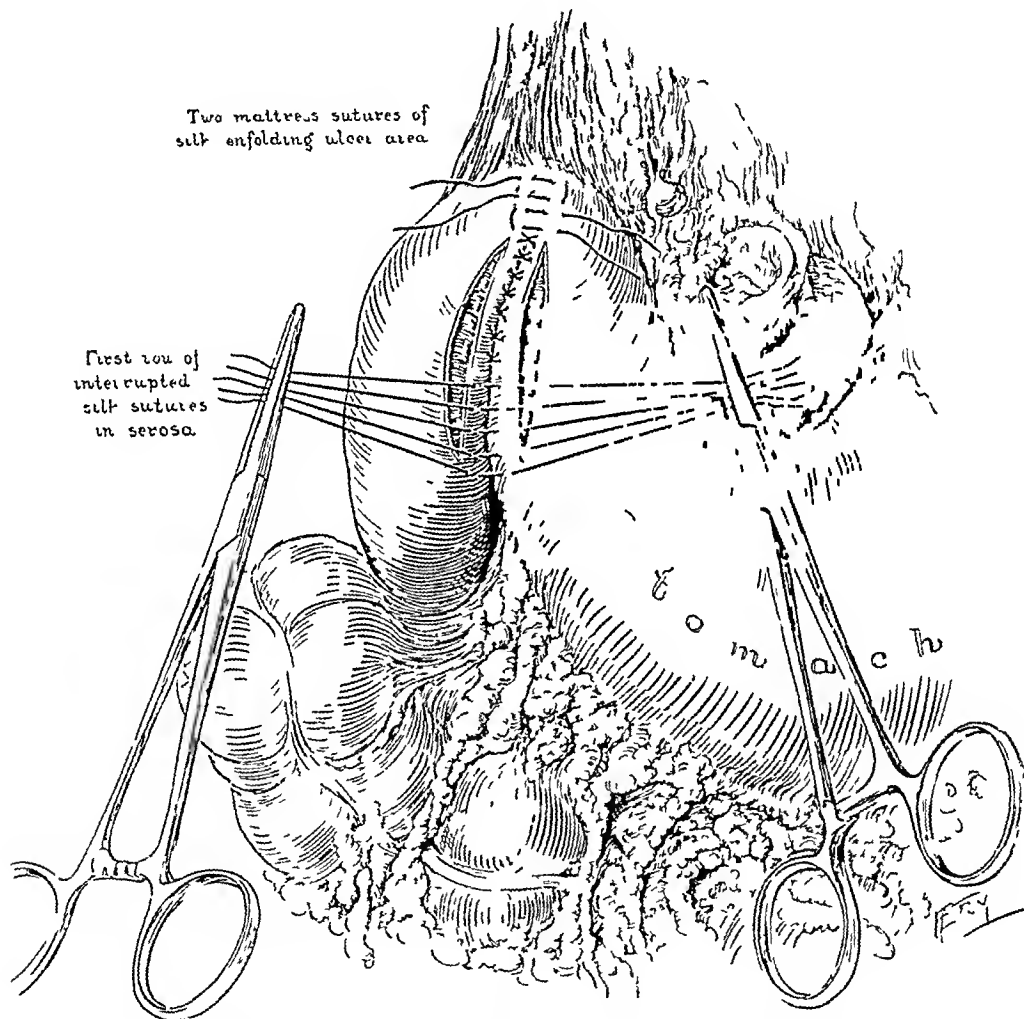


FIG 6—Gastroduodenostomy for obstructing ulcer with an angulation (Balfour's Gastro Duodenostomy ) (Mayo Clinic, W B Saunders Co)

cavity and the peritoneum covering the posterior surface of the duodenum and pancreas

By thus freeing the posterior surface of the pancreas and duodenum primarily, it is possible to lift the inferior angle together with the third or inferior horizontal portion of the duodenum, superiorly or upward and anteriorly or forward, thus putting on a stretch the loose areolar tissue which binds the posterior surface of the third portion of the duodenum to the posterior wall of the abdomen, and the inferior and anterior surface to the fused peritoneal coverings of the greater omentum and transverse mesocolon

(It is to be noted that in the shifting of the stomach and large intestine in the embryo, the right side of the duodenum which is covered with peritoneum becomes the posterior aspect and fuses, excepting the first part, by loose areolar tissue to the peritoneum of the posterior abdominal wall. The peritoneal covering of the anterior surface then fuses in the same manner with the combined peritoneal coverings of the anterior leaf of the transverse mesocolon and the greater omentum.)

In this manner, by gentle blunt finger dissection the whole of the third or inferior horizontal portion of the duodenum, together with the entire head of the pancreas may be freed quickly and quite easily. No blood vessels of any consequence are encountered because the duodenum and pancreas receive their blood supply from the superior and inferior pancreaticoduodenal arteries which run between the head of the pancreas and duodenum (Fig 7). Thus the duodenum and pancreas are lifted free from the posterior abdominal wall revealing the right kidney, vena cava, vertebral column and aorta. Mobilization of the third portion of the duodenum is thus accomplished up

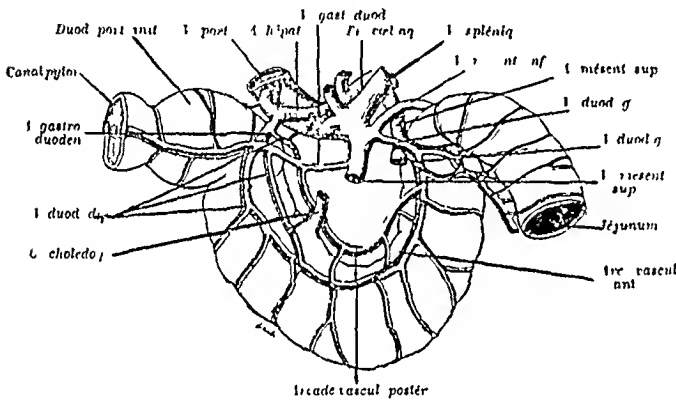


FIG 7

to and beyond the point where the superior mesenteric vein and artery cross the anterior surface of this portion of the duodenum (Fig 8 and Pl II Fig 1). The peritoneal reflections of the mesentery of the jejunum have in the embryo fused with the peritoneum covering the anterior surface of the

end of the third and the beginning of the fourth portion of the duodenum so that the passage of the latter through the mesentery of the jejunum is readily mobilized. The superior mesenteric vein and artery course in the mesentery of the jejunum at a higher level about midway between the surface of the duodenum and the jejunum, and it is not necessary to expose them. The middle colic vein and artery are displaced slightly to the left and forward presenting no difficulty or hindrance whatsoever. The transverse colon and omentum are then lifted up so as to expose the posterior surface of the transverse mesocolon and the left surface of the mesentery of the jejunum. The fourth or ascending portion of the duodenum can be seen beneath the peritoneum covering the posterior abdominal wall (Fig 8). The superior and inferior duodenal fossæ are at once seen (Fig 8) with the reflection of peritoneum which above forms the superior duodenal reflection covering the areolar and muscle tissue running from the left crus of the diaphragm to the wall of the duodenum, and called Treitz' ligament (Fig 8). This ligament or reflection is cut and an incision made in the peritoneum along the left margin of the ascending or fourth portion of the duodenum

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The inferior reflexion of peritoneum bounding the inferior duodenal fossa is also cut if present. The entire fourth or ascending portion of the duodenum is in this way mobilized and lifted free from its bed. Thus the lower half of the second or descending portion, the inferior angle together with the third or inferior horizontal portion, and the fourth or ascending part of the duodenum, is completely mobilized, lifted from its bed, and is freely movable in all planes right or left, superior or inferior, and anterior. As stated above, the freeing of the posterior surface of the pancreas is also accomplished up to the origin of the superior mesenteric artery from the anterior surface of

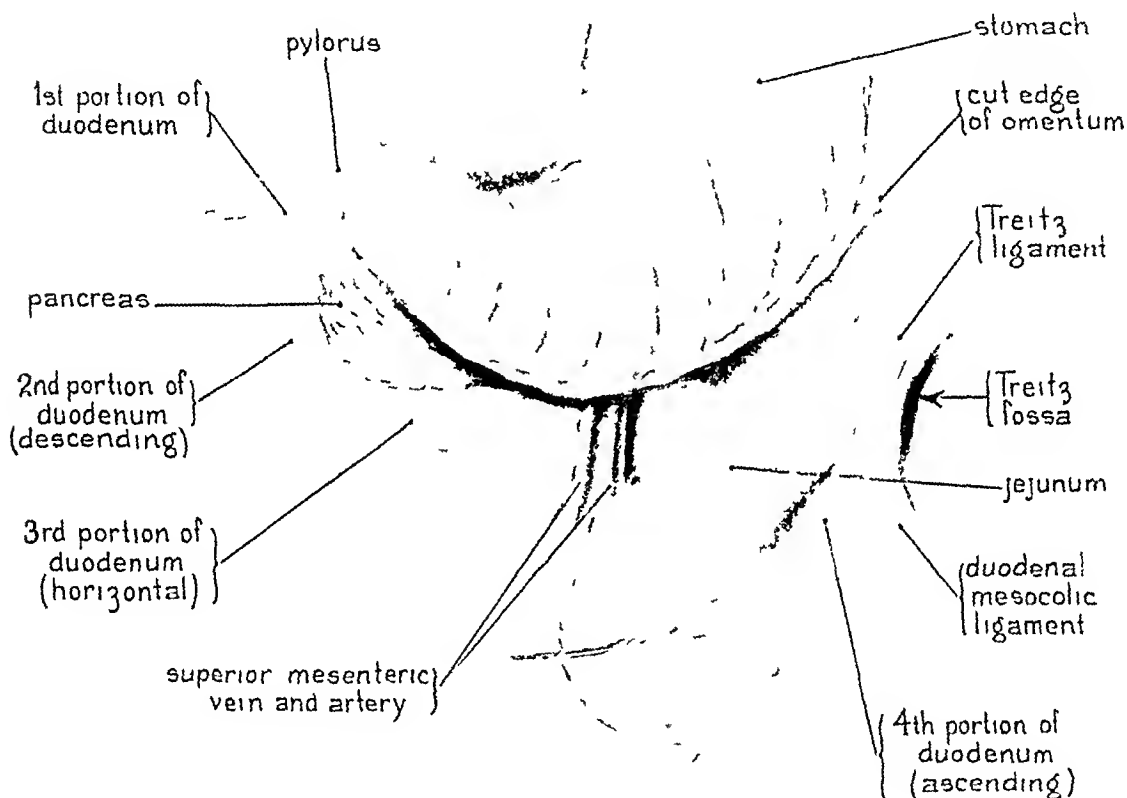


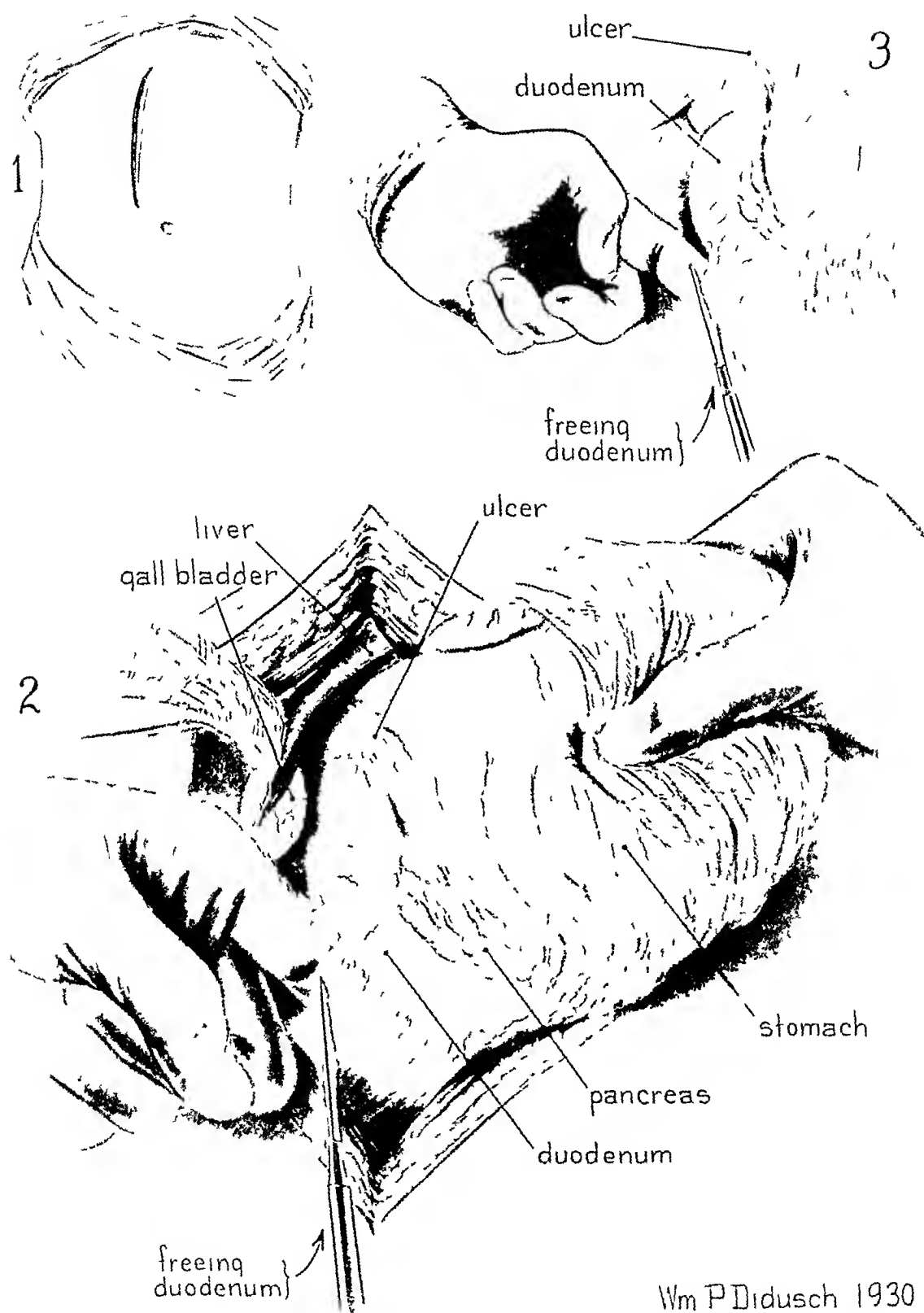
FIG. 8—Drawing with colon removed from abdomen and greater omentum cut away from stomach to demonstrate the various portions of the duodenum. In this instance the jejunum passes from the left to the right side. In a large number of cases the jejunum runs down to the left instead of turning on itself to the right. This, however, does not interfere with the mobilization of the duodenum. The peritoneum overlying the third and fourth portions of the duodenum is incised at the inferior margin of the duodenum, and the duodenal mesocolic ligament together with Treitz' ligament are cut so as to free the duodenum and allow it to pass transversely to the right behind the mesenteric vessels. In some cases it would seem unnecessary to free the left or fourth portion of the duodenum in order to accomplish a gastroduodenostomy between the third portion and the stomach. However, in order to be certain of no kinking at the junction of the third and fourth portions of the duodenum behind the mesenteric vessels it is better to free the duodenum to the left of the mesenteric artery and vein.

the aorta. This latter procedure gives an extensive mobility to the third or horizontal portion of the duodenum. The transverse colon is then replaced into its normal position. The third or horizontal portion of the duodenum can now be brought up into the abdominal wound and anastomosed to the greater curvature of the stomach with great ease (Pl. II, Fig. 1). If desired, the anastomosis may be made higher up on the anterior surface of the stomach. It is surprising how mobile this third or horizontal portion of the duodenum can be made. Mobilization of the left portion of the duo-



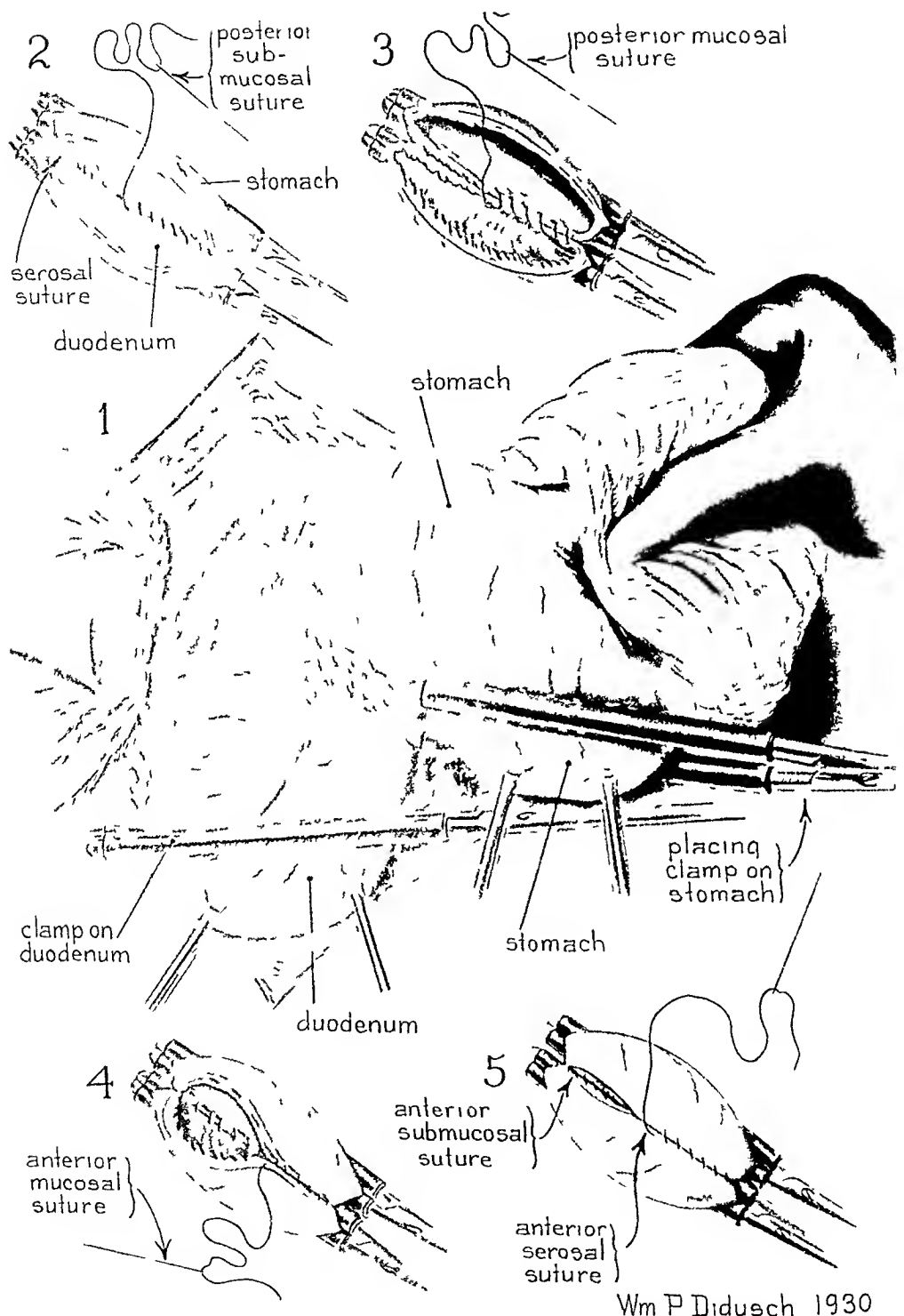
denum or the ascending fourth part prevents any knuckling or kinking of the duodenum at the junction of the third inferior horizontal with the fourth ascending portion subsequent to the anastomosis. The location of the superior mesenteric vessels at a higher level in the mesentery leaves so much space between them and the bodies of the vertebrae that free passage of the duodenum is obtained beneath these vessels. Thus the free mobility of the third and fourth portion of the duodenum prevents kinking about these vessels because the lateral displacement of the fourth part of the duodenum to the right is only limited by the width of the mesentery of the jejunum, which is between 20-23 centimetres or eight to nine inches. The anastomosis between the stomach and duodenum is then performed five to fifteen centimetres below or distal to the ampulla of Vater, using the infra-papillary portion of the duodenum. The anastomosis may be accomplished in the following manner: applying the three-layer suture used by Dean Lewis with clamps or without the use of clamps, employing the Halsted presection mattress sutures. The former method is preferred because it is accomplished with less soiling and is more rapid. The anterior stomach (Pl II, Fig 1) wall in the most dependent portion of the pyloric antrum is grasped by two mucosa clips placed about seven to eight centimetres apart, just above the point of entrance and departure of the vessels of the greater curvature, and lifted up so that a rubber-shod clamp may be so placed that one blade the inferior, rests almost directly on the greater curvature of the stomach. The rubber-shod clamp is gently compressed, only sufficiently to hold the stomach in place and prevent bleeding during the operative procedure. In a similar manner, the third or inferior horizontal portion of the duodenum is clamped in a rubber-shod clamp. The mucosa clips are removed and the anastomosis begun. A continuous suture of No "C" catbolized waxed silk is introduced by means of a straight, round non-cutting needle. This enables one to accurately place the suture through the peritoneal and muscular coats, engaging a small but definite portion of the submucosa and remaining outside of the lumen of the viscus (Pl II, Fig 2). To accomplish this the needle must be a non-cutting one and should be introduced perpendicular to the surface of the viscus to be sewed. A silk suture improperly introduced into the lumen of the intestine will become infected and act as a drain along which infected material may escape, contaminating the entire suture line and causing the formation of adhesions or even suppuration. An incision is then made about one-half of one centimetre anterior to the first posterior suture line, through the peritoneum and muscular layers of the stomach and duodenum, for a distance of about six or seven centimetres, determining the length of the anastomosis to be made. This incision exposes the submucosa which herniates up as the lips of the incised peritoneal and muscular layers retract. A second posterior suture of chromic No 1 catgut is then introduced (Pl II, Fig 2), which engages the submucosa as well as the peritoneal and muscular coats. This second posterior row serves not only to give a broad peritoneal approximation between it and the first posterior suture line, but also as a hæmostatic suture

# INFRA-PAPILLARY GASTRODUODENOSTOMY



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PLATE I



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PLATE II

The lumina of the stomach and intestine are then opened and the mucosal layers both posterior and anterior are approximated by an over and over simple continuous suture of No 2 plain catgut (Pl II, Figs 3 and 4) The second posterior row of No 1 chromic catgut suture is continued, after locking this stitch at the angles, to become the second anterior row of suture (Pl II, Fig 5) The mucosa and cut edge of submucosa, muscularis and peritoneum are inverted by this line of suture The rubber-shod clamps are removed and the first posterior row of No "C" carbolyzed waxed silk is continued anteriorly, inverting again the first two anterior sutures Care must be taken to invert as little of the stomach and intestine as possible so as not to cause too great an inturned flange (This will become flattened out in the course of eight weeks, in the dog) A Halsted mattress suture is usually placed just beyond each end of the anastomosis to relieve the suture line of any possible tension or traction The remainder of the mobilized duodenum is allowed to fall back into its bed A row of obliterating Halsted mattress and Lembert silk sutures are placed in the pylorus, causing a temporary stenosis (Pl III, Figs 1, 2 and 3) The entire first portion, together with the upper half of the second or descending portion of the duodenum, is avoided in this operation The object being to have these portions of the duodenum fixed and anchored by their normal attachments to the extreme right In this manner, the pulling over of the stomach and duodenum to the left is prevented If all four parts of the duodenum are mobilized a kinking to the left may occur over the mesentery of the jejunum\* Besides, mobilization of the first and upper part will in no way affect the mobility of the third or horizontal portion of the duodenum

Thirteen cases of chronic peptic ulcer have been successfully operated on by this method in the last two years Two cases were operated on in 1925 The immediate, and so far, the ultimate results, in all, have been excellent There has been no re-occurrence of their pre-operative distress, and so far they have been entirely free of all gastric symptoms In all cases there has been a pronounced decrease in the free and total acidity of the gastric juice with bile always grossly visible in the stomach contents The emptying time of the stomach has been about normal or slightly accelerated

*Discussion*—The advantages of this type of infrapapillary gastroduodenostomy are as follows

(1) The anastomosis is formed between the stomach and the duodenum, which is physiologically better suited to receive the acid gastric juice than the jejunum

(2) So far an instance of spontaneous ulceration of the third or inferior horizontal portion of the duodenum has not been reported so that the fascial cleavage about this portion of the duodenum is normal and not obliterated due to the scarring attendant on an ulcer or periduodenitis so commonly encoun-

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\* This occurred in one of the early cases operated upon in the Provident Hospital causing a high obstruction

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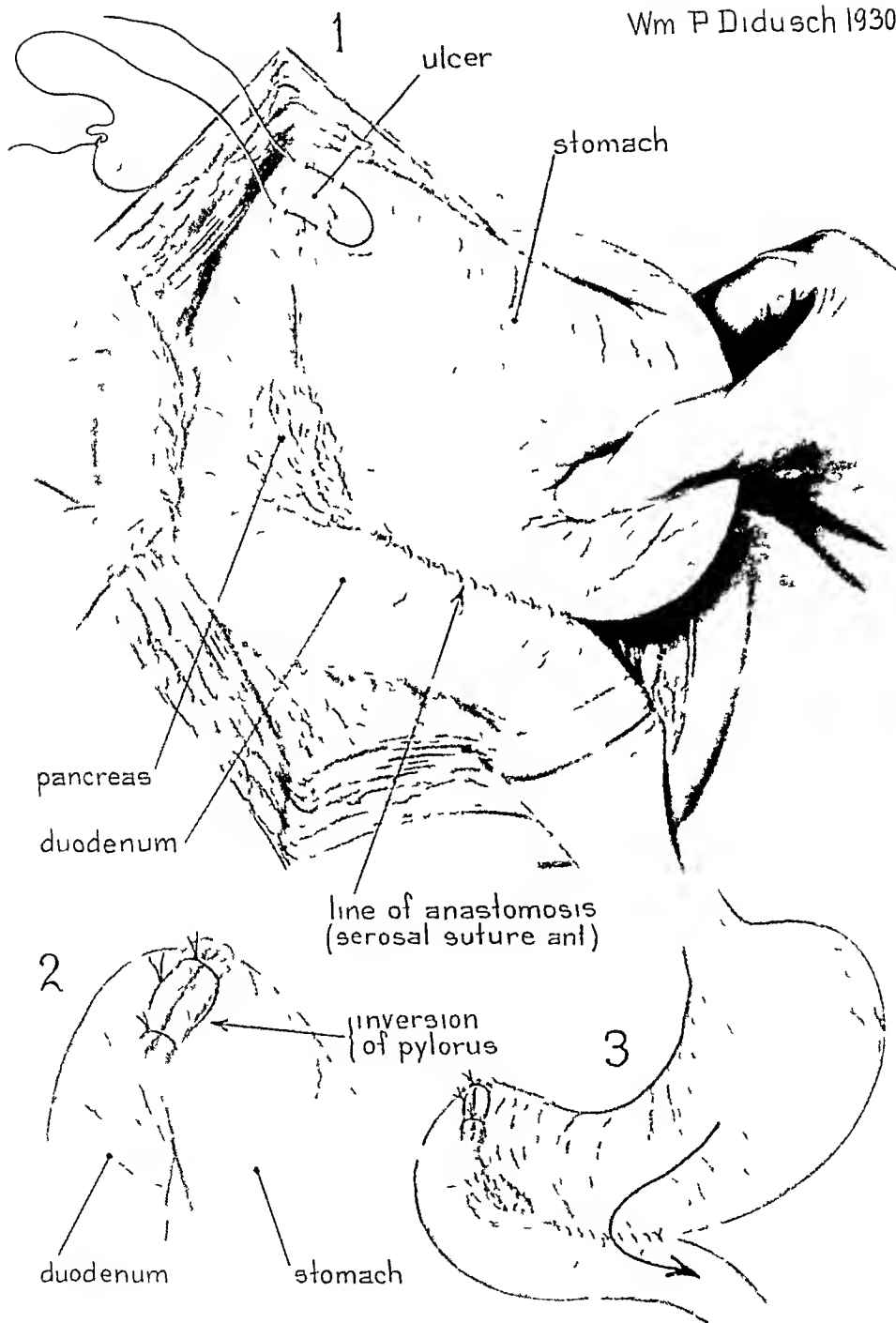


PLATE III

tered in the first and second portions. This fact insures relative ease in the mobilization of the duodenum and also provides a normal duodenal wall for use in suturing. Often in operating upon the first or superior portion, one is forced to suture indurated duodenal wall in the immediate vicinity of an ulcer.

(3) The third or inferior horizontal portion of the duodenum is more anteriorly situated and more accessible than the first and second parts.

(4) In the mobilization of the third portion there are no structures such as the ductus choledochus and pancreatic ducts in the vicinity which might be injured during mobilization.

(5) Marginal ulcer which according to different observers is reported as occurring in from 3 per cent to 25 per cent of cases of gastrojejunostomy does not occur in the duodenum following gastroduodenostomy.

(6) The transverse mesocolon does not have to be transected as in gastrojejunostomy. A large per cent of the post-operative complications of gastrojejunostomy has been due to obstruction at the site of the anastomosis because of the contraction of the mesocolon on the jejunum.

(7) The most dependent portion of the stomach is the greater curvature of the pyloric antrum where the anastomosis in this operation is made. Thus from a mechanical standpoint the maximum drainage is afforded. The stomach contents are always pushed towards the pylorus so that an opening in the antrum affords more prompt and efficacious drainage than one further back towards the fundus of the stomach.

(8) The continuous and abundant reflux of bile, pancreatic and duodenal secretion into the stomach causing a neutralization of the free and combined acid, is probably the most important factor in the operative or surgical treatment to bring about healing of a peptic ulcer. Following pyloroplasty or suprapapillary gastroduodenostomy, the hyperchlorhydria persists after operation and, according to the general opinion which has been held in the past, the great desideratum, was to establish an opening between the stomach and intestine which would remain patulous and through which at the same time the bile and stomach contents would not tend to regurgitate. In all operations in which the anastomosis is performed above the ampulla of Vater, undoubtedly the minimum amount of duodenal contents will find its way into the stomach. However, our opinion of the most desirable effect following such operations has changed, so that now the maximum reflux of bile and duodenal contents into the stomach is to be preferred.

(9) Excision of an ulcer or a large portion of the stomach may be performed simultaneously with this form of infrapapillary gastroduodenostomy.

Undoubtedly, the major therapeutic effects of an operation upon the stomach for the surgical treatment of chronic peptic ulcer are the establishment of prompt and efficacious drainage of the stomach together with alkalimization of its secretions by the reflux of the duodenal contents. In an as yet unpublished experimental study on dogs and clinical observations on patients in the Johns Hopkins Hospital<sup>13</sup> together with the recent study of Gauthier<sup>14</sup>

the observation has been made that in order to produce a maximum reflux of duodenal contents into the stomach the opening into the intestine must be below the ampulla of Vater. The different types of pyloroplasty and suprapapillary gastroduodenostomy between the stomach and the first or upper part of the second portion of the duodenum, all have a persistent post-operative high acid content in the stomach and delayed emptying time. In contrast to these findings, following the infrapapillary gastroduodenostomy the reflux of bile is abundant in the gastric contents with a resultant low post-operative acidity, and the emptying time of the stomach is somewhat accelerated above normal.

The advantages of this procedure in respect to gastroenterostomy using the jejunum are, first the duodenum is undoubtedly better suited for the reception of the acid gastric contents. Second, spontaneous ulcer has not been observed in this third or inferior horizontal portion of the duodenum and no instances of marginal ulcer occurring in the duodenum have occurred in this clinic following any type of operation between the stomach and duodenum. Third, the necessity of going through the mesocolon is avoided. Fourth unquestionably the closure of the pylorus is an advantage and therefore it is mechanically better to place the junction of the stomach and intestine as near the pyloric end as possible. In this operation the stoma between the stomach and intestine is much further to the right than in gastrojejunostomy. Thus if the pylorus is closed, the large blind pouch of stomach remaining after gastrojejunostomy is avoided.

Regardless of the fact that the great portion of the duodenum has lain in a retroperitoneal position and the free mesothelial surface of its original peritoneal covering has become somewhat covered with a very loose areolar tissue, nevertheless, the peritoneal layer remains distinct, and possesses the power of agglutination originally ascribed to it in 1824 by Jobert<sup>15</sup>. No difficulty has been encountered in the healing of this surface of the duodenum.

Although the mobilization of all but the superior portion of the second part of the duodenum has been performed in this operation for the treatment of benign ulcerations of the stomach and duodenum, the surgical importance of this procedure is more far-reaching. When the third or inferior horizontal portion and the fourth or ascending portion of the duodenum is completely free, not only the entire duodenum but also a considerable length of the jejunum may be drawn posterior to the superior mesenteric vessels with great ease and without the slightest kinking of the bowel or disturbance of the circulation in the mesentery.

When the jejunum is drawn underneath the superior mesenteric vessels to the right side, the latter are rotated slightly less than 90° in their long axis which does not interfere with the blood flow through them. This rotation of the mesentery of the jejunum, resulting from a complete freeing of the duodenum, makes available for use on the right side of the mesentery and above the mesocolon, a sufficient length of jejunum to perform an anastomosis with the duodenum just below the ampulla of Vater, or with the stomach high up on the fundus. The importance of this procedure is

at once evident in all cases in which it is desirable to resect the duodenum for traumatic or pathologic changes and further to facilitate the technical difficulties encountered in secondary operations for marginal ulcer or obstructions following gastrojejunostomy

*Conclusions*—For the reasons given above it is felt that the infrapapillary gastroduodenostomy is to be preferred to other types of gastroenterostomy. It is to be recognized that there is a small but definite percentage of cases in which this operation is not applicable

Mobilization of third (horizontal) and fourth (ascending) portions of the duodenum and the first portion of the jejunum with their retromesenteric displacement from the left to the right side is of value as well in surgical procedures for conditions other than chronic peptic ulcer

Every case of chronic ulceration of the stomach and duodenum should be considered individually from the surgical standpoint and it is only by the application of various operative procedures dependent upon the anatomic and pathologic conditions which supervene and with regard for the physiologic effect of such various operative procedures upon the stomach that the best results will be obtained. It is in the hope that this operative procedure may prove helpful that it is called to the attention of those interested in the surgical treatment of ulcerative lesions of the stomach and duodenum

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# HEMOPHILIC ARTHRITIS

(BLEEDER'S JOINTS)

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IN SPITE of the fact that the majority of hemophiliacs who reach the age of puberty are subject to joint disturbances, hemophilic arthritis is a rather rare condition and most of the affected individuals know that they are bleeders and promptly inform the surgeon of this fact when any operative procedure is considered. Consequently, it does not occur to the average surgeon that he may some day open a hemophilic joint under an erroneous diagnosis. Thus, in spite of the facts that a hemophilic arthritis may closely resemble conditions for which operative intervention is indicated and that the literature contains several reports of surgical tragedies which resulted from operations upon hemophilic joints under an erroneous diagnosis. Consequently, it is important that surgeons who operate upon joints should know thoroughly the clinical picture of hemophilic arthritis.

In this paper I wish to report an unhappy experience of my own in which a fatality was narrowly averted, and also wish to describe for the first time in English the clinical picture and pathology of hemophilic arthritis as well as to make certain additions to our knowledge of the subject which have resulted from the study of my operated case.

N McG, aged thirteen, was referred to the St Louis Children's Hospital from the dispensary for the removal of a painful tumor over the mesial condyle of the right femur. The dispensary diagnosis was old calcified hematoma. He was admitted to the hospital September 5, 1929.

His father was believed to be living and well, but had not been heard from for several years. His mother died following childbirth, but not from hæmorrhage. One sister was living and well at the age of twenty-six. Five sisters and brothers had died in infancy from pneumonia or diphtheria. No history of bleeders in the family.

The boy had had measles and pertussis in infancy. He has always bruised easily and large, hard, blue-black swellings followed the bruises and lasted several days. At the age of three he bled several days from a small cut in the tongue. He always had to bandage small cuts very tightly in order to stop the bleeding. He has had occasional nose bleeds, but they never lasted over thirty minutes. There was no especial bleeding following the removal of the deciduous teeth. From time to time he has been troubled with painful swellings of one or more joints. The swellings usually occurred spontaneously as he was not able to recall any injury. The involved joint became enlarged, tense, and painful. This condition persisted for from a few days to a week and then gradually subsided and the joint returned to normal. An exception to the above was the right knee, as will be mentioned below. The joints involved were the right knee, both ankles, both elbows, and various joints of both hands and fingers.

He is quite positive that the subcutaneous hematomata and joint swellings have been much less frequent during the past two years.

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At the age of five years he fell and struck the right knee on the pavement. The knee became markedly swollen and painful and the patient remained in bed about a month. The pain gradually disappeared and the swelling decreased, but some swelling persisted over the internal condyle of the femur and the knee remained flexed. This swelling and flexion deformity have persisted until the present time and the swelling has always been quite tender. From time to time the knee has been markedly swollen and painful. These attacks have usually followed a slight injury and have caused him to remain in bed for from four to fourteen days. He does not know how many times the knee has been swollen, but states that the number is large. The last time was about six months ago.

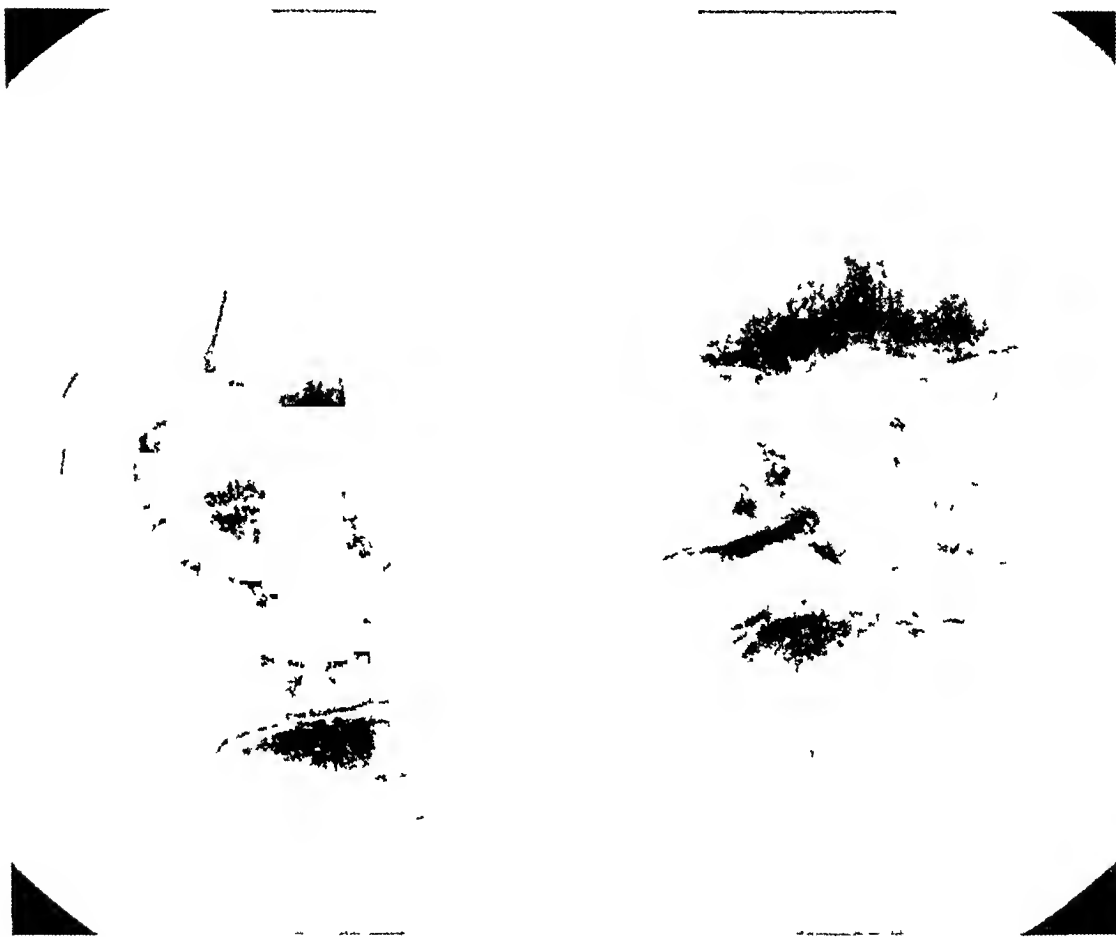


FIG. 1.—X rays of knee of hemophilic arthritis before the operation. The characteristic dark shadows in the periarthritic tissues do not show in the prints, but the larger radiated areas may be seen in the femur and tibia.

He was a pale, slender boy, height sixty inches, weight seventy-nine pounds. General physical examination was negative excepting a soft blowing systolic murmur at the heart apex. All joints were normal except the right knee. There were 30 degrees of permanent flexion of the right knee and a valgus deformity of ten degrees. Flexion was limited to 90 degrees by pain and motion was accompanied by soft crepitus. There was no actual shortening of the extremity or atrophy of the calf, but there was 1.5 centimetres atrophy of the thigh. The right knee was slightly larger than the left and the internal condyle of the femur was unusually prominent. On palpation no excess fluid was demonstrable in the joint, but the joint capsule was felt to be thickened and constricted. Its margins had a rubber-like consistency and could be rolled beneath the fingers. The thickening was especially marked over the internal condyle of the femur and here a hard cartilage-like mass was palpable. There were no redness or

local heat, but this mass was quite tender and was continuous with the thickened capsule and could be moved slightly upon the underlying bone

The above history was obtained after the operation. The case came under my care when I was asked to look after the orthopædic service for a few days while the surgeon in charge was out of the city.

*Laboratory findings*—Urine, normal. Wassermann, negative. Red blood-cells, 4,590,000. White blood-cells, 9400. Hb, 70 per cent, Blood clotting time, seven minutes (done in the dispensary).

*X-Ray findings*—(Fig 1) Antero-posterior view, right knee. The X-ray shows moderate enlargement of the bones of the right leg, the lower end of the femur being nine centimetres broad on the right and eight centimetres on the left. The bones are quite atrophic. The epiphyseal line is not markedly irregular, but is doubly contoured, especially over the external condyle, and is broadened. In addition to the atrophy there is a rather large circular area of rarefaction in the mesial portion of the external condyle of the femur, which is surrounded by a narrow zone of dense bone. This area is one and one-half centimetres in diameter. There is a smaller ovoid area of rarefaction in the internal condyle near the joint surface and a similar small area near the border of the external condyle.

The condyles of the tibia are enlarged in about the same proportion as are those of the femur, and the bone is rarefied, and shows a circumscribed area of rarefaction similar to those in the femur and located just below the spines of the tibia. The joint space is narrowed, the articular surfaces are roughened and the small areas of rarefaction in the inner condyle of the femur are unusually prominent while the lateral borders of the condyles are serrated. The intercondylar notch in the femur is moderately broadened and deepened. The spines of the tibia are slightly more prominent than are those on the other side.

In the periarticular tissues, especially over the mesial portion of the joint, are rather dense shadows which are in places circumscribed and quite sharply defined. These do not appear to be attached to the bone, but merge into the mass of the surrounding capsule, which is more opaque than usual.

*Lateral view, right knee*. The bones are atrophic and the joint space is narrowed. There is a large area of rarefaction one and one-half centimetres by two centimetres in the epiphysis of the femur which begins at the epiphyseal line and extends downward almost to the end of the condyle. This is surrounded by a thin zone of dense bone. There is a similar smaller defect in the anterior portion of the epiphysis of the tibia. The joint capsule appears to be unusually dense and casts a definite shadow, which is especially marked in the region of the posterior capsule. The patellar tendon bulges forward as though the fat pad were enlarged and the fat pad casts a shadow which is more dense than is that on the other side. The articular surfaces of all the bones are very thin and slightly roughened.

As I had obtained only a history of an injury with resultant deformity and disability, it was my impression that this was a traumatic arthritis and that the tumor was a mass of fibrous tissue or cartilage which should be removed. This impression seemed to be confirmed by a casual glance at the X-ray which I first saw just before I made the incision.

*Operation*—September 9, 1929. Under a tourniquet, a longitudinal incision about five inches long on the mesial side of the patella was carried down through the capsule of the joint. The skin and subcutaneous tissue and joint capsule were apparently normal. Beneath the fibrous capsule and separated from it by a small amount of areolar tissue a layer of dense fibrous tissue was encountered. This was incised in the line of the incision down to the synovial membrane without opening the synovial cavity. The synovial membrane was unusually dark in color. A small opening was made in it and about twenty cubic centimetres of blood flowed from the joint cavity. This blood was dark in color, though not the purplish color of venous blood, and it

contained no clots. At this point in the operation the diagnosis of hemophilic arthritis was made, but since the damage was done there seemed to be no reason why an attempt should not be made to relieve the patient of the tender swelling over the internal condyle provided he survived the effects of the operation. Consequently, the operation was continued.

The incision in the synovial membrane was enlarged and the joint was inspected. The synovial membrane was dark chocolate in color and the joint cavity was filled with hypertrophied synovial folds and villi. The articular cavity was smaller than normal and this was particularly true of the quadriceps bursa, which extended only about half an inch above the patella and was crossed by several bands of synovial tissue.

The fat pad was unusually dense and fibrous in character and a thick fold of dense synovial tissue extended along the mesial border of the patella and tended to overhang the articular margin of that bone. The articular cartilage on the femur, tibia and patella was yellowish-brown in color and contained many areas in which the cartilage was either thinned or had entirely disappeared and in the eroded areas the underlying bone was covered by a delicate chocolate-colored connective tissue.

These areas of thinning and erosion in the articular cartilage were irregular in size and contour and suggested the sharply demarcated maplike appearance as described by König<sup>1</sup>. There was also some marginal erosion of the articular cartilage and a very thin narrow marginal zone where the cartilage appeared to be invaded by the hyperplastic synovial tissue but no definite pannus was present and there was no tendency to the formation of marginal osteophytes or ecchondroses. The erosion and thinning of the cartilage seemed to be from the underlying bone as the eroded areas did not correspond to the areas of greatest pressure in the joint and in the thinned areas the surface of the cartilage was smooth. The semilunar cartilages were pale, reddish-brown in color, but were normal in other respects.

The patella was not displaced outward as it was not deemed advisable to enlarge the incision sufficiently to permit this. The thickened mass of synovial tissue and dense fibrous subsynovial tissue which covered the anteromesial aspect of the mesial condyle of the femur was excised *en bloc*, as was the thick band which extended along the mesial border of the patella. Then with a knife a small bit of the margin of the articular cartilage of the femur approximately one-half by one centimetre was excised. It was found that the underlying bone was very atrophic and could be cut easily with a knife.

All visible vessels were then ligated and the wound was carefully closed in layers and a pressure dressing applied before the tourniquet was removed.

The patient was returned to the ward in good condition and orders were left that he be kept quiet with morphine, the limb elevated and that he be watched for transfusion and transfused immediately if any unusual amount of bleeding occurred.

During the afternoon the leg became cyanotic and covered with small purpuric spots (subcutaneous hæmorrhages). Consequently, the dressing was loosened.

September 10—The day after the operation, fresh blood appeared on the dressing at 11 00 A.M. The dressing was tightened and the bleeding stopped, but reappeared in about an hour and continued until four o'clock in the afternoon, when it seemed to cease spontaneously. He was transfused at 5 00 P.M., receiving 300 cubic centimetres of whole blood. After the transfusion the bleeding began again and I saw him for the first time since the early morning, at which time his condition had been good. I removed the large blood-soaked pressure dressing and found that there was no general ooze but that a small artery was loose near the upper end of the wound. The bleeding could be stopped at will by compressing this against the femur. This was ligated by passing a curved needle into the incision and under the artery and out through the skin. It was not necessary to open the wound. Bleeding stopped.

September 11—Second transfusion, 500 cubic centimetres whole blood.

September 16—The knee began to swell and was quite painful.

September 19—Temperature was  $39.8^{\circ}$  by mouth. The knee was very tense and painful and a small amount of blood was oozing from the wound. The skin edges were necrotic in places from the tension. Knee aspirated and 120 cubic centimetres of old blood were removed. Smears and cultures of this were negative for bacteria.

September 20—Knee again very tense and skin edges beginning to separate. Eighty cubic centimetres of old blood were removed by aspiration. A good deal of blood remained in the knee, but this was apparently clotted. Smears and culture of the aspirated blood were negative for bacteria.

September 22—The wound continued to look bad and a plaster bandage was applied and the extremity elevated.

September 23—A window was cut in the dressing and all sutures were removed. As the sutures were removed the edges of the wound separated, revealing a large blood clot (about eight by five centimetres) which completely filled the anterior portion of the joint. This was firmly adherent to the front and inner side of the femur.

September 25—Third transfusion, 500 cubic centimetres whole blood.

October 1—The clot was lifted out, leaving a necrotic base.

October 14—Plaster bandage removed and Thomas splint and adhesive traction applied to correct the flexion deformity, which was now about  $60$  degrees. The



FIG. 2.—Photograph on the left and X-ray on right of part of synovial membrane removed at operation. The dense shadow cast by this tissue in the X-ray is due to the large amount of iron in it.

necrotic tissue had by this time separated and the wound was comparatively clean and its edges were being pulled together by adhesive strips. From this time on the convalescence was uneventful and the patient left the hospital on crutches.

The blood-platelet count was first done September 11, after the first transfusion, and daily thereafter until September 26. On the eleventh the platelet count was 284,000 and it rose slowly to 386,000 on the eighteenth. At this time the patient was started on twenty minims of irradiated ergosterol (acterol) daily and the platelet count rose rapidly to 745,000 on the twenty-second and remained at about this level during the period of observation.

The red blood-cells numbered 4,100,000 on admission and 3,810,000 after the second transfusion. Although there was no further bleeding the red blood-cells gradually dropped to 2,380,000 on September 25. This occurred while the platelet count was steadily rising to 745,000, under the influence of acterol. After the third transfusion the patient was put on a liver diet and on October 18 the red blood-cells were 4,100,000, hæmoglobin 70 per cent, white blood-cells 11,400, and clotting time eight and one-half minutes (one-half minute longer than it was before the operation).

The temperature rose after the operation and reached  $37.6^{\circ}$  on the fourth day. On the eleventh day the temperature reached  $39.8^{\circ}$ . At this time the knee was dis-

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tended with blood and infection was suspected, but no growth was obtained from the aspirated material

*Pathological Examination of Material Removed—Gross Description—*(Fig 2) The specimen consists of a mass of synovial membrane five by four centimetres in diameter and two smaller pieces. The synovial membrane is dark chocolate color. Much of the surface is covered by numerous large and small rounded villi, folds and synovial bands. Some of the villi are pedunculated and are attached to the surface by long slender pedicles while others are sessile in character. Many of the folds and villi branch extensively and in some areas they form an intricate moss-like structure. On section these large villi are quite friable, contain no visible fibrous tissue, have the appearance of raw calves' liver and some of them contain deep clefts or cavities which are filled with unclotted blood. The subsynovial tissue contains a layer of dense white fibrous tissue which in some places is four millimetres in thickness. The delicate synovial membrane can be stripped from this with comparative ease.

In addition to the above, there is a small fold of dense fibrous tissue about one

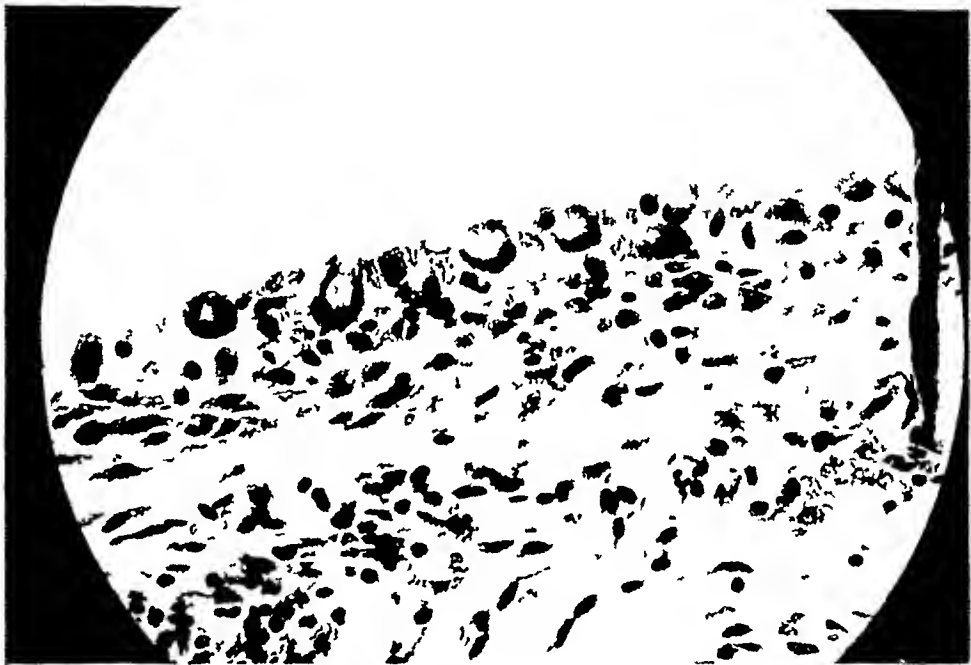


FIG 3—Synovial surface. The large cells along the surface are monocytes and the large granules are pigment granules. Four millimetres objective.

centimetre in width, one-half centimetre in thickness and three centimetres in length. The synovial membrane over this is only slightly hypertrophied and is less dark in color than are the villi.

The third specimen consists of a small block of cartilage two millimetres in thickness and five millimetres square with a bit of the attached synovial membrane and underlying bone.

*Microscopic Examination—*Projecting from the synovial surface are many folds and villi. These are large and very numerous in the loose or areolar areas of the joint and are small and few in number or even absent in the dense fibrous areas.

The most striking feature in the sections is that the tissues, and especially those near the synovial surface, are loaded with granules and masses of yellowish-brown pigment.

*Synovial Surface Layer—*Over most of the surface the synovial lining cells are moderately increased in size and number, forming a surface layer which is from four to ten cells in thickness. The majority of these cells are the moderately enlarged synovial lining or fixed connective-tissue cells. They range from spindle to stellate

or ovoid in shape and possess a faintly basophilic protoplasm and a rather deeply staining nucleus which is larger than that of normal synovial lining cells. Many of these cells contain a few or moderate number of the pigment granules (Fig 3).

Scattered through the surface layer are great numbers of large phagocytic cells (macrophages), many of which are loaded with the yellowish-brown pigment. Many of these cells contain a large pale nucleus with one or more large nucleoli and are characterized by a sharply defined clear zone in the protoplasm on one side of the nucleus. This clear zone is roughly spherical in shape, like ground glass in appearance, and free from the pigment with which the rest of the cytoplasm may be loaded. It corresponds to the rosette of the monocyte and these cells are believed to be monocytes. A few of the monocytes contain two nuclei and occasional mitotic figures are found in the connective-tissue lining cells.

In the dense fibrous areas of the joint the surface is composed of a layer of collagenic tissue and the cells are for the most part imprisoned in lacunae and buried

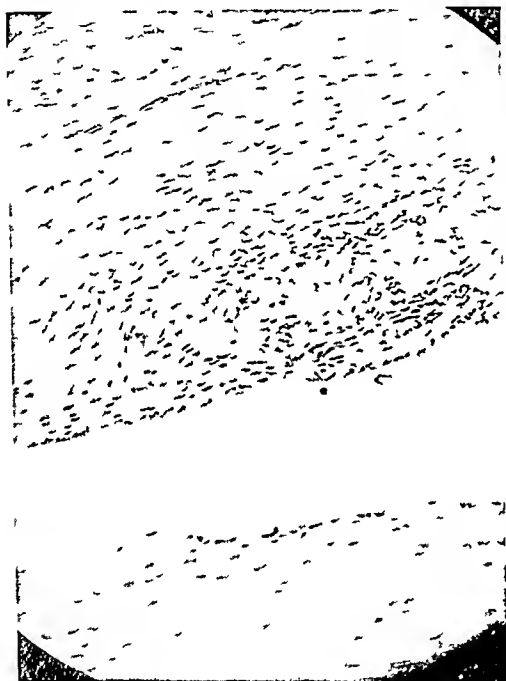


FIG 4

FIG 4—Fibrous areas of the synovial surface. Note that in the upper surface the cells are imbedded in lacunae. Light millimetres objective.



FIG 5

FIG 5—Vascular area of synovial surface. The dark material is blood pigment. Sixteen millimetres objective.

beneath the surface (Fig 4). In spite of the fact that these cells are enclosed in lacunae many of them are about twice as large as are synovial cells in similar situations in normal joints and are not only enlarged but possess long processes, many of which extend up to the articular surface. None of these cells contains any of the yellowish pigment which is so abundant in the cells covering the areolar areas of the joint surface, nor is this dense tissue invaded by macrophages. In the transition zones between the fibrous and the areolar areas a few of the synovial cells contain minute granules of pigment.

*Subsynovial Tissue*—In the loose or areolar areas of the joint surface the subsynovial tissue is extremely vascular and infiltrated with macrophages and contains large amounts of yellow pigment (Fig 5). The ground work of this tissue is composed of rather coarse bundles of collagenic fibrous tissue separated by fat and areolar tissue. The macrophages are scattered everywhere through the tissue and

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are in many places collected into masses. A large percentage of these macrophages are loaded with the yellow pigment. In addition to the macrophages there are a considerable number of small round cells or lymphocytes scattered through the subsynovial tissue and occasionally these are collected into small nodules similar to those seen in chronic arthritis and sometimes these are perivascular in arrangement. The blood-vessels vary greatly in size and in the thickness of their walls. In many places the tissue is extremely vascular and wide blood spaces with very thin walls lie just beneath the layer of synovial lining cells. In other places the tissue contains large numbers of small thick walled arteries.

In addition to the blood-vessels the subsynovial tissue contains a large number of spaces which are lined by synovial lining cells. In the sections these spaces appear to be cysts in the subsynovial tissue, but examination of the gross specimen indicates that most if not all of the apparent cysts are really deep clefts in the subsynovial tissue.

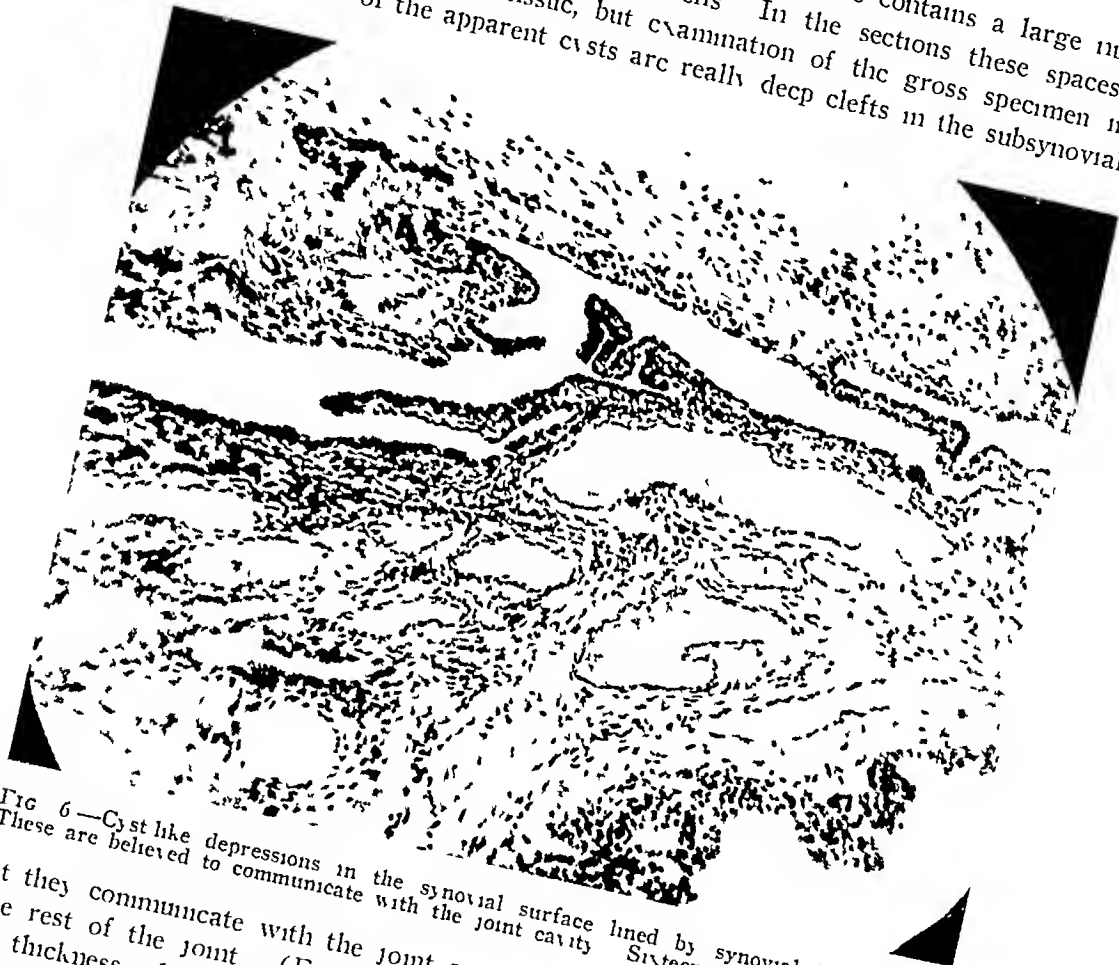


FIG 6—Cyst like depressions in the synovial surface lined by synovial lining cells. These are believed to communicate with the joint cavity. Sixteen millimetres objective.

and that they communicate with the joint cavity and are lined by the same type cells as is the rest of the joint (Fig 6).

The thickness of the layer of areolar subsynovial tissue varies greatly in different sections. In some places there is only a thin zone beneath the layer of lining cells (Fig 7) while in others there is a wide vascular subsynovial layer (Fig 8).

The subsynovial tissue rests on a layer of very dense collagenic fibrous tissue made up of bundles of fibres which run in various directions. The greater part of this dense fibrous tissue is not infiltrated by round cells or macrophages, but it contains occasional circumscribed areas into which the macrophages have penetrated and a few areas are seen in which the tissue is infiltrated by red blood-cells apparently the result of a recent hæmorrhage, and these are mixed with a moderate number of macrophages which are engorged with yellowish pigment.

Occasional clefts or possibly cysts lined by cells loaded with pigment granules penetrate deeply into the subsynovial fibrous tissue lying between collagenic bundles.



and in other areas the tissue is made up of a mass of collagenic bundles which are separated by small blood-vessels and islets of engorged macrophages

In the dense fibrous areas of the joint the collagenic fibrous tissue approaches or may even comprise the synovial surface and in these areas it is not infiltrated with macrophages

The villi vary greatly in size and number and tend to resemble in structure the type of tissue from which they spring. They are most numerous in the loose areolar areas of the joint surface and here the villi are very complex in structure, containing many indentations and folds, and are extremely vascular and markedly infiltrated with macrophages (Fig 9). In the areas where the subsynovial layer is very thin, the villi are short and slender and relatively simple in structure (Fig 7), and in some parts of the dense fibrous area the villi are composed of dense fibrous tissue and contain no blood-vessels or macrophages

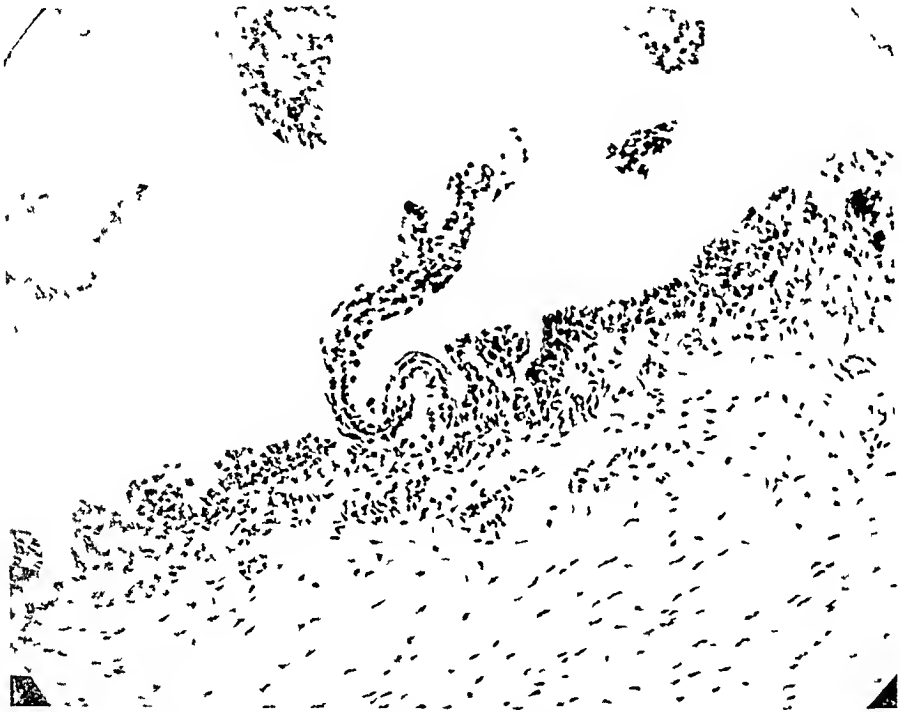


FIG 7—Transition zone between areolar and fibrous type of synovial surface. Eight millimetres objective

The yellowish-brown pigment which is scattered through the tissues is obviously blood pigment and gives a strong iron reaction. The greater part of this pigment is found in the bodies of the macrophages but a considerable amount is lying free in the tissue in masses varying from minute granules to conglomerates fifteen or more microns in diameter. In addition to the pigment in the macrophages minute granules of pigment are present in the fixed connective-tissue cells and in the connective-tissue cells making up the walls of the blood-vessels and even in the endothelial lining cells of both arteries and veins in areas where the tissue contains large amounts of pigment. In other words, in such areas practically every type of cell present contains some of the old blood pigment

*Cartilage Margin*—The margin of the articular cartilage is overlapped by a layer of rather vascular synovial and subsynovial tissue (Fig 10). This has invaded the cartilage for a short distance. The surface of the cartilage has undergone fibrosis and is invaded by vascular connective tissue. The synovial layer contains numerous small branching villi which are quite vascular and contain large numbers of macrophages

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which are loaded with pigment. There is very little evidence of hyperplasia in the cartilage and the underlying bone is extremely atrophic so that in many places the cartilage practically rests upon the bone marrow and the cancellous bone of the epiphysis.

*Later Condition*—June 10, 1931, the boy came in for an examination by request. At the present time he is fifteen years old, weighs 105 pounds and has just finished his first year of high school. He states that he has had no pain in the knee since leaving the hospital and that the operation has completely relieved his symptoms, with the exception of limitation of motion in the right knee. He walks three miles to school and during the past year he has missed only one-half day of school and this was because of a cold. He swims, plays ball, and does practically everything but skate. He still has a tendency to bruise after an injury, but this is not as severe as it used to be. Occasionally he hurts his fingers playing ball and they become swollen and painful for a few days, but the symptoms clear up spontaneously. From time to time he

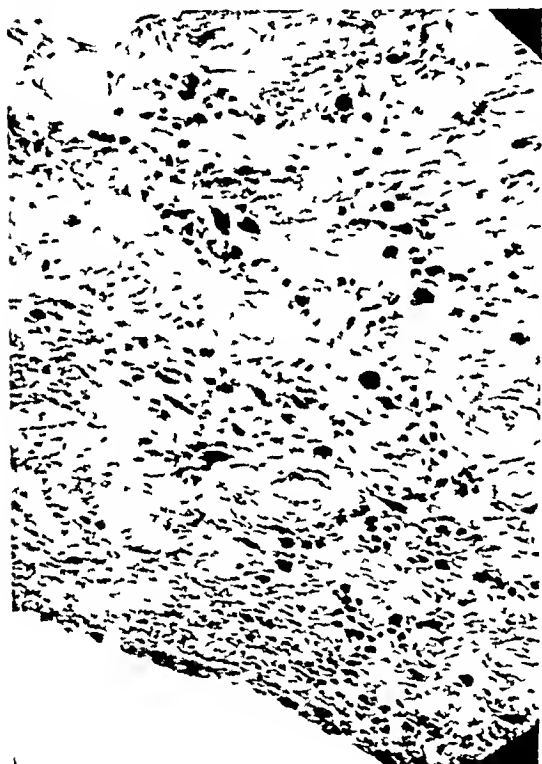


FIG 8

FIG 8—Areolar type of synovial surface. The large dark masses in the tissue are blood pigment and much of this is lying free in the tissue. Sixteen millimetres objective.

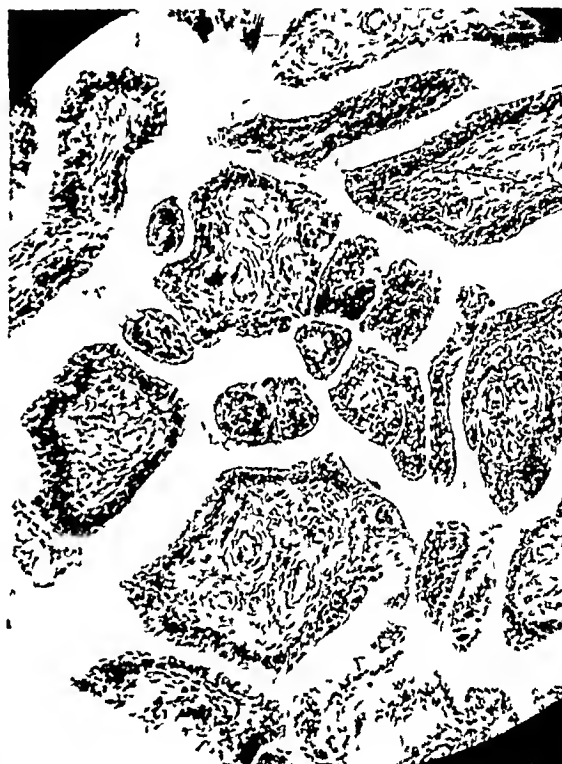


FIG 9

FIG 9—Cross sections of multiple small vascular villi. Sixteen millimetres objective.

falls on his hands, and when this occurs the wrist, especially the left wrist, is apt to be swollen and painful for a few days, but this also clears up spontaneously. Six days ago he fell and injured his right hip. Two days later the hip became sore, stiff and painful and the hip is now in a position of flexion and he walks with considerable limp. He states that this is the first time that this hip has ever been injured and that up until this recent injury he was able to walk with scarcely a limp.

The patient is a tall, slender boy and apparently normal except for the right hip and right knee (Fig 11). The right hip is flexed and moderately sensitive on movement. There is no swelling or external evidence of injury. The hip is slightly tender on deep palpation. There is permanent flexion of 60 degrees and flexion is limited to 90 degrees. Rotation is limited about 50 per cent.

*The Right Knee*—There is permanent flexion of 25 degrees and the flexion is

limited to 90 degrees. There is a large, slightly tender scar over the anteromesial aspect of the knee and there is slight crepitus on motion. There is no pain in the knee with motion or weight bearing. There is some discoloration over the tibial tubercle which the patient states is due to a recent fall.

Blood-clotting time eight and one-half minutes by test-tube method (anything under fifteen minutes normal).

X-rays taken June 10, 1931, as compared with those taken before the operation, show decrease in the bone atrophy, disappearance of the thickened tissue around the internal condyles which was removed at the operation, increase in the size of the bones and slight increase in the irregularity of the articular surfaces (Fig 12). An X-ray of the hip taken at this time is negative.

*Historical*—The American literature on hemophilic arthritis is very meagre. With the exception of descriptions in text-books the only articles which I have found on the subject are those of Doub and Davidson,<sup>2</sup> Youmans,<sup>3</sup> and Wilson.<sup>4</sup>

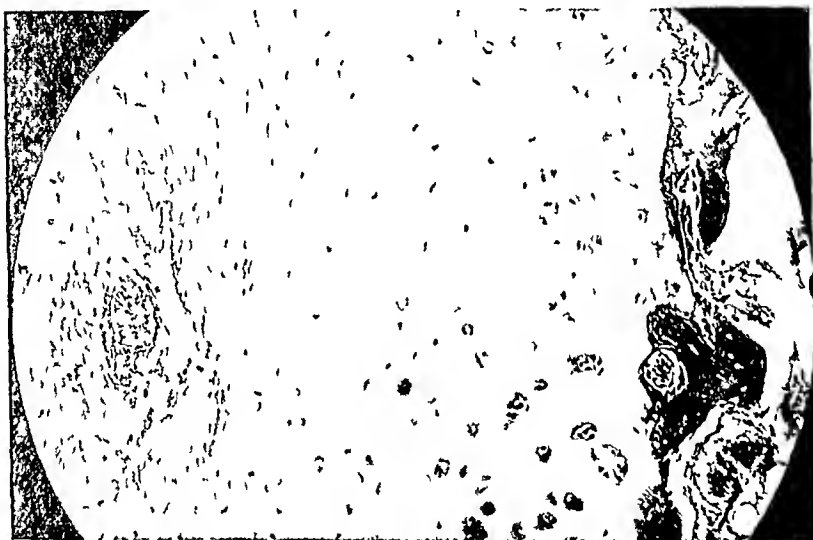


FIG 10.—Articular cartilage near the margin. The surface on the left is being invaded by vascular connective tissue while the subchondral bone on the right shows marked atrophy. Eight millimetres objective.

As the German and French literature has been reviewed by König,<sup>1</sup> Linsler,<sup>5</sup> Zesas,<sup>6</sup> Du Pan,<sup>7</sup> Freund,<sup>8</sup> and Reineke and Wohlwill,<sup>9</sup> it will be considered only briefly in this paper. The older authors considered the joint affections in bleeders as being due to rheumatism and Volkmann is given credit for first differentiating the joint disturbances in hemophiliacs from rheumatism. In his text-book on diseases of the bones and joints published in 1868 he stated that spontaneous hemothroses occurred in scurvy and hemophilia and that they might also result from trauma. The next year Remert and Gasses expressed the opinions that bleeders' joints were due to intra-articular hæmorrhage.

The modern conception of the hemophilic arthritis dates from König's paper which appeared in the *Klinische Vorträge* in 1892. He divided the condition into three stages: (1) Hemarthrosis, (2) panarthrits, and (3) regressive stage, and warned against operation under a mistaken diagnosis.

## HEMOPHILIC ARTHRITIS

*Pathology of Hemophilic Arthritis*—The gross changes in the joints were accurately described by König and relatively little has been added to his original description. The microscopical changes in the synovial membrane are most completely described in the pathological description of the material in my case which is included in this paper and the microscopical changes in the cartilage and bone are most completely described in the papers by

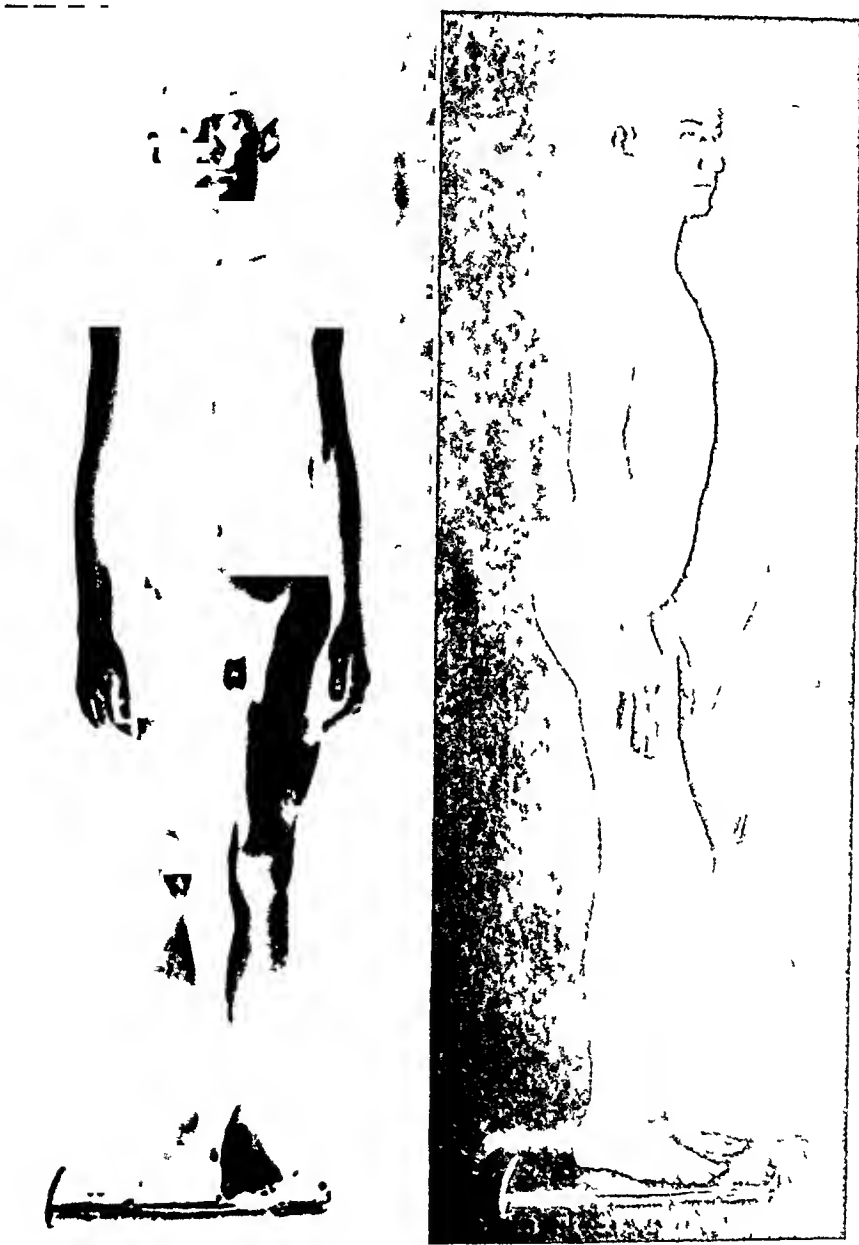


FIG. 11.—Photograph of patient one and one half years after the operation. Note the flexion deformity of the right knee and a large scar over the internal condyle. When this photograph was taken there was an acute hemiarthrosis in the right hip.

Freund<sup>8</sup> and Remeke and Wohlwill.<sup>9</sup> From the literature and my own observations the pathological changes can be described briefly as follows:

*Changes in the Soft Tissues*—The hemophilic starts out with apparently normal joints. Due to some injury, or even without any known injury, bleeding into a joint may occur. This may begin early in life as in the case

illustrated in Fig 13, where the first bleeding into the knee occurred at the age of two years and eight months. The joint becomes distended with blood under pressure which may be equal to the systolic pressure of the blood as the blood in the joint does not clot, at least not for a long time, and is in communication with that in the blood-stream.

In addition to its mechanical effect the blood in the joint acts as an irritant and hyperplasia of the synovial membrane occurs. As I have shown elsewhere,<sup>10</sup> a somewhat similar hyperplasia may be produced experimentally in animals by repeated injections of blood into normal joints. With this



FIG 12—X rays of operated knee one and one half years after operation. Note the increased roughening in the joint and the decrease in the bone atrophy. The large rarefied area in the femur persists and the opaque synovial tissue which was removed at the operation is absent in the film.

synovial hyperplasia there is an accumulation of macrophages in the sub-synovial tissues and these are constantly wandering back and forth between the joint cavity and subsynovial tissues.<sup>11</sup> These macrophages phagocytize the red blood-cells, become engorged with them, and as the red cells disintegrate the blood pigment remains in the body of the macrophages. These engorged macrophages settle down in the subsynovial tissues beneath the fibrous capsule of the joint and eventually die, thus setting free the blood pigment. This blood pigment may remain *in situ* or may be picked up by other macrophages. Eventually the bleeding ceases, the blood in the joint

## HEMOPHILIC ARTHRITIS

is absorbed and the joint tends to return to normal, but in a hemophilic the bleeding recurs from time to time and with each recurrence there is an addition to the amount of blood pigment which is laid down by the macrophages in the subsynovial tissues

Each new hæmorrhage is an added irritation to the synovial membrane and this hypertrophies with the formation of folds and villi. Not only is the blood pigment taken up by the macrophages, but, in the advanced cases, as I have shown in this paper, practically all of the cells in the vicinity contain some of the fine pigment granules. In other words, the area around the joint is saturated with blood pigment. While some of this enters the lymphatics and general circulation much of it remains permanently in the tissues around the joint just as does India ink when it is injected into joints.<sup>11</sup> An idea of the large amount of pigment which may be deposited in some of these joints is conveyed by the fact that in one of Freund's<sup>8</sup> cases in which the synovial membrane was analyzed for iron it was found that 71 per cent of the ash was iron. Eventually, if the tendency to bleed ceases, the synovial membrane tends to return to a more nearly normal state, the synovial cells decrease in size and number, and the villi tend to atrophy.

The accumulation of blood pigment in the subsynovial tissues and probably the repeated occurrence of bleeding into a joint under pressure serves as an irritant which results in the formation of a layer of dense fibrous connective tissue in the subsynovial tissue. In the case on which I operated this resulted in a marked decrease in the size of the synovial cavity and the subsynovial fibrous tissue envelope around the joint was distinct from the fibrous capsule of the joint and separated from it by thin areolar tissue. In such a case a tendency to fibrous ankylosis is present and this fibrous ankylosis is partly due to thickening and shortening of the fibrous capsule and ligaments, and partly to the production of new fibrous tissue in an abnormal situation. Not only does the new fibrous layer limit motion in the joint, but it also inhibits the resorption of blood from the joint cavity.

*Changes in the Cartilage*—The cartilage probably remains normal for



FIG 13—Photograph of a severe hemophilic seven years of age with very severe contractures of both knees

a long time, but eventually it becomes eroded around its margins by the encroachment of the hyperplastic synovial membrane just as occurs in any infectious or atrophic arthritis. In addition to the marginal destruction there is a variable amount of spotty destruction of the cartilage over the articular surface of the bones. These areas of destruction are preceded by death of the cartilage cells and fibrosis and degeneration of the matrix. Whether this is the result of the blood in the joint or whether it is the result of subchondral hæmorrhages is not known. However, the cartilage destruction does not coincide with pressure areas in the joint and the destroyed areas are irregular in contour and have been described by König<sup>1</sup> as map-like in character. This map-like appearance is, we believe, characteristic of a hemophilic joint. Where the cartilage has been destroyed the underlying bone becomes covered with a layer of connective tissue and there may result a depression or cavitation in the bone which may be filled with a blood clot or organized hematoma or lined by connective tissue. There is little tendency for the production of connective tissue between the articular surfaces of adjacent bones and so far as we know bony ankylosis has not occurred in any hemophilic joint.

*Changes in the Bone*—The characteristic feature in the bone is that the intra-articular portions of the bone may contain cavities. These cavities may be in the nature of simple depressions either on the sides of the intra-articular portions of the bones or in the articular surfaces or they may occur deep in the cancellous bone. The origin of these cavities is not definitely known. Freund<sup>8</sup> and Remeke and Wohlwill<sup>9</sup> believe that they are the result of progressive erosion of the bone which is brought about in the same manner as is the bone destruction by an aneurism. That is, they believe that the increased intra-articular pressure is a very important factor in the production of the cavities and that the underlying bone is gradually eroded by the pressure of the blood in the joint. In addition to this they believe that hemophilic blood exerts some as yet unknown chemical effect upon bone which results in its rapid absorption.

In support of this theory Remeke and Wohlwill<sup>9</sup> describe the marked erosion of the cortex of the femur which occurred beneath a subperiosteal hematoma from which the patient died and in which the autopsy specimen was carefully studied and described. I do not know whether either or both of these theories are correct. It seems to me, however, that the most plausible explanation of the bone destruction with cavitation is that it results from intra-osseous hæmorrhage. As we know, the bone destruction does not occur until late in the disease. At some stage of the disease the bones become markedly atrophic as a result of disuse. It seems quite probable that intra-osseous hæmorrhage may be a fairly common phenomenon in atrophic bone and may result from ordinary use without definite trauma. In a hemophilic such an intra-osseous hæmorrhage would tend to progress and result in the production of an area of aseptic inflammation in the involved area, and this

## HEMOPHILIC ARTHRITIS

in turn would tend to result in the absorption of the bone by the inflammatory tissue. Whether or not this theory is true we do not know.

The areas of bone destruction are frequently so extensive that they are clearly visible in the X-ray and when present are characteristic of advanced hemophilic arthritis. Not only are they present in the interior of the bone, but there is a subperiosteal erosion of the bone which results in a pseudo-lipping due to the undermining of the articular margins. Occasionally, as a result of loss of cartilage on the articular surface,<sup>12</sup> true marginal osteophytes or exostoses may occur in these joints, but these are relatively rare. If, as the patient grows older, the tendency to bleed into the joint becomes less or ceases there may result a joint which closely resembles that of the ordinary hypertrophic arthritis. On the other hand, with repeated bleedings and progressive destruction of the articular surface marked deformities may occur.

*Clinical Picture*—The clinical picture varies with the stage of the process and most authors follow the classification of König, who recognized three stages: (1) Hemarthrosis, (2) panarthritis resembling tuberculosis, and (3) regressive stage with erosion of the joint borders. I am not able to separate the panarthritic from the regressive stage and do not think that this has been done successfully by König or any other author whom I have consulted. Consequently, only two types of bleeders' joints will be recognized: (1) Acute hemarthrosis and (2) chronic arthritis.

(1) *Stage of Acute Hemarthrosis*—This is the stage of acute hæmorrhage into a joint which in other respects may be practically normal or may be the site of a chronic hemophilic arthritis. The joint disturbances in hemophilia nearly always begin in childhood and the surgeon may see the patient during the first attack, but it is usually possible to obtain a history of similar attacks in the involved joint or in other joints, and it will be found that these previous disturbances either cleared up spontaneously or after a few days' rest and that the involved joints returned to normal or a chronic arthritis developed. The joint disturbance may have occurred spontaneously, even while the patient was asleep in bed, but in most instances it will have followed a minor injury such as a contusion or unusual strain.

It is characteristic for the effusion to appear rapidly and marked swelling may occur within a few minutes so that the patient may even see the joint swell, as sometimes occurs in acute Charcot joints. In some instances the swelling is a very gradual process and may progress slowly over a period of several hours or days. The degree of swelling ranges from a joint containing a slight amount of excess fluid to one which is extremely tense and distended with fluid under considerable pressure. (Fig. 14.) In a case cited by Reineke and Wohlwill<sup>9</sup> the intra-articular pressure was so great that the blood spurted over two neighboring beds when a needle was inserted into the knee.

Pain may be slight or intense and tends to vary directly with the degree of swelling and pressure within the joint. The same is true of the func-



tional disability These joints vary from those with slight swelling and no limitation of motion or pain on motion or even on weight bearing to those which are greatly swollen, very tense and painful, and in which weight bearing is prohibited by pain and practically all motion is prevented by pain and muscle spasm

On physical examination the patient is usually a slender, pale, anæmic-looking male and presents nothing remarkable except the involved joint The findings in the involved joint vary with the amount of the intra-articular hæmorrhage and the tension on the capsule If the amount of excess fluid is not great the joint may show only slight swelling and in the case of a superficial joint the signs of excess fluid in the joint are present If the



FIG 14—Acute hæmorrhosis in right ankle Same case as preceding

blood is present under pressure the joint may be markedly swollen and acutely tender and the tenderness may extend up and down the limb (Fig 14) Local heat and redness are not present, but a joint which is covered by a relatively thin layer of tissue such as a finger or an ankle-joint may be definitely blue (cyanotic) in color

In the severe cases the joint is fixed in a position of moderate flexion by muscle spasm and both active and passive motions are limited There may be some local heat, but redness and œdema are not present As a rule the bleeding is into the joint and the swelling follows the outline of the synovial cavity, but there may be more or less extra-synovial hæmorrhage and in such cases dark bluish areas may appear in the subcutaneous tissues near the joint These subcutaneous discolorations resemble the bruises which are so

frequent in hemophiles and are most evident three or four days after the beginning of the joint bleeding. Unless the joint is involved in a chronic arthritis there is no muscle atrophy or deformity other than that incident to the muscle spasm in the severe cases.

The temperature tends to be slightly elevated and in exceptional cases may reach 39 or 40 degrees C and there is usually a moderate leucocytosis, but the prostration found in acute infectious processes is absent.

In the roentgenogram the bones tend to be normal, but the joint cavity is distended with fluid and this, being blood, casts a shadow which is rather more dense than that usually seen in acute synovitis.

(2) *Chronic Arthritic Stage*—This may be defined as the stage in which the involved joint fails to return to an apparently normal condition after the hæmorrhage. It may follow the first hæmorrhage into the joint, as occurred in the knee of the operated case reported in this paper, but this is unusual, and permanent changes in the joint do not ordinarily occur until after several such attacks. A rather extreme case is that reported by Gocht,<sup>13</sup> in which hemarthrosis of one knee had occurred forty-five times, but the blood had always been resorbed and normal function restored.

In the arthritic stage it will be found that after an acute hemarthrosis the joint remained swollen, tender, sore, and painful for several weeks or months and that there is more or less permanent disturbance of function with a tendency to repeated attacks of acute swelling and pain which are usually the result of minor injuries. It should be pointed out that this stage resembles ordinary chronic arthritis in that it tends to progress by remissions. That is, the joint quiets down after an acute attack and there is more or less restoration of function, but the joint is not so good as it was before the attack and with recurring attacks there is an increased permanent disability.

During an acute attack in the arthritic stage the joint is swollen, painful, tender, and disabled as in the stage of hemarthrosis. The difference between the two stages is that in the arthritic stage the swelling tends to be less because it is limited by the subsynovial fibrous tissue and the blood in the joint is not resorbed promptly, and contracture, deformity, peri-articular thickening and muscle atrophy are present and tend to increase after each fresh hæmorrhage.

After the acute hæmorrhage has subsided, the muscle atrophy, deformity, limited motion, and disability persist. The joint is more or less swollen and this is partly due to a small amount of excess fluid (blood) which is almost constantly present in these joints, but largely to thickening of the periarticular tissues. This thickening follows the outline of the synovial cavity and on palpation the indurated subsynovial tissue may be felt. In addition to the above there may be more or less actual thickening of the bones entering into the joint and this may be general or local from the ossification of old subperiosteal hematomas.

In the regressive stage of König the tenderness and pain on motion have

largely disappeared, but there is soft crepitus on motion and the amount of motion is more or less limited. In severe cases there may be fibrous ankylosis with practically no motion in the joint, but I know of no case in which true bony ankylosis has occurred.

The most severe deformities which I have seen in hemophilic arthritis are illustrated in Figs 13 and 15. This seven-year-old boy is a severe familial hemophilic and trouble with the knees began at the age of two years. On admission there was permanent flexion of 90 degrees in one knee and of 110 degrees in the other. On account of the deformities the patient has not walked for over five years. The parents did not wish us to attempt to

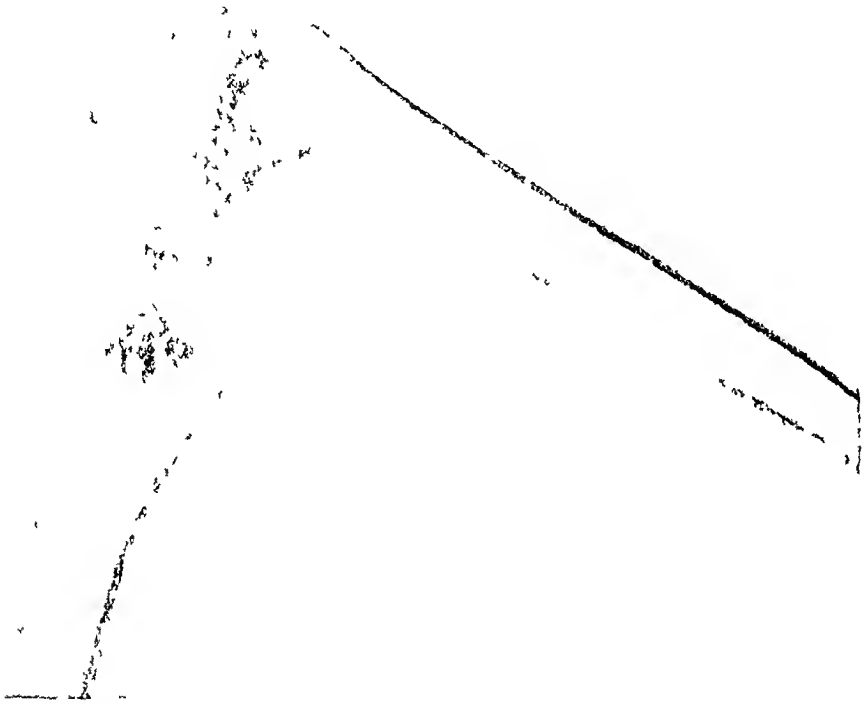


FIG 15 — X-ray of knee joint of preceding case. Note the marked atrophy in the bones, roughening of the joint surfaces and cloudiness of the joint capsule.

straighten the knees, but brought the boy to the Shriners' Hospital because of the acute hemarthrosis of the ankle (Fig 14). A few days after his admission, while lying in bed the patient developed acute hemarthrosis in one elbow, and one finger and a moderate hematoma behind one ear and a very large hematoma (about five by ten inches) on the back and right shoulder. All of these were present at one time.

The knees of the above case resembled those of a typical case of Still's disease (atrophic, rheumatoid, or chronic infectious arthritis). The knee of my operated case resembled a traumatic arthritis and the knees of the man whose X-rays are shown in Figs 16 and 17 resembled a hypertrophic arthritis. During the intervals between attacks this man had relatively little disability and on physical examination the knees presented only moderate

periarticular thickening and soft crepitus on motion and slight limitation of motion

It is thus evident that the chronic hemophilic joint may present a very variable clinical picture and that these chronic joints are subject to acute hæmorrhages which result in periods of marked disability (panarthrititis of König) which may be prolonged or clear up within a week or two and that after these acute symptoms have cleared up the joint returns to the original relatively painless chronic arthritic stage (regressive stage of König). But the acute symptoms may return at any time. As the patients grow older the hæmorrhages tend to become less frequent. For instance, the man whose knee is shown in Figs. 16 and 17 now goes two years or more without trouble, whereas during childhood he had several acute hemarthroses a year, and the same is true of my operated case.

The temperature and blood picture tend to be normal except during an acute hæmorrhage into the joint when there may be more or less fever and a moderate leucocytosis. The blood-clotting time tends to be prolonged to a variable degree.

*Röntgenographical Appearance*—The X-ray findings have been described by Gocht,<sup>13</sup> Mermingas,<sup>14</sup> Hubscher,<sup>15</sup> Neumann,<sup>16</sup> Mankiewicz,<sup>17</sup> Rhonheimer,<sup>18</sup> Montonari,<sup>19</sup> Engels,<sup>20</sup> Dun Pan,<sup>7</sup> Petersen,<sup>21</sup> Cary,<sup>22</sup> Freund,<sup>8</sup> Doub and Davidson,<sup>2</sup> and Reineke and Wohlwill.<sup>9</sup> In the acute hæmorrhagic stage there are no changes in the bones, but the blood in the joint casts a shadow which is slightly more dense than that of the usual synovial effusion.

In the arthritic stage the X-rays reveal abnormalities in the soft parts and bones which have been variously described as resembling the changes produced by tuberculosis, hypertrophic arthritis, atrophic arthritis, or traumatic arthritis. As a matter of fact, while they may present some of the changes found in any of the above conditions the röntgenograms of a typical case of hemophilic arthritis may present characteristic features which make it possible to make the diagnosis from the X-ray alone. These features are a markedly increased density of the synovial tissues and crater-like depressions or punched-out defects in the intra-articular portions of the bones. However, many cases do not present these characteristic features and these cannot be diagnosed by the X-ray alone.

The increase in density in the synovial tissues often takes the form of definite shadows resembling areas of calcification. These shadows are present in the recesses of the joint and follow the outline of the synovial cavity. A careful examination of the affected knee-joints in our operated case gives one the impression that the synovial membrane is thickened and more or less calcified. These shadows are much more definite and sharply outlined than is the cloudiness of the joint space in tuberculosis and are more regular in outline and general in distribution than are the extra-articular calcified masses in Charcot joints. In addition to the above the patella may float on account of effusion into the joint and the patellar tendon may be bowed forward by the fluid or hypertrophied fat pad beneath it.



FIG 16

FIG 16—X ray of knee joint in a man forty one years old Chronic hemophilic arthritis



FIG 17

FIG 17—Lateral view of same case as preceding Note the cloudiness in the joint capsule and the punched out area in the articular surface of the patella

## HEMOPHILIC ARTHRITIS

The joint space is narrowed to a variable degree and may be obliterated, but bony ankylosis apparently does not occur. The articular surfaces of the bones are more or less irregular and indented and the ends of the bones entering into the joint are more or less deformed. In the knee the condyles, especially of the femur, may be broadened or less broad than normal. A rather characteristic picture is one in which the sides of the condyles of the femur and tibia present definite hollowed-out defects just above or below the articular margin giving one the impression of border osteophytes. And border osteophytes have been described in these joints, but they are quite unusual. In knees presenting these lateral defects the notch between the femoral condyles is usually broader and deeper than normal and the spines of the tibia are apt to be deformed. There may be considerable new bone formation from the calcification of a subperiosteal hematoma and this is especially apt to occur in the elbow. In the hip the head of the femur may be deformed in such a manner that the X-ray picture resembles that of Legg-Calve-Perthes' disease (*osteochondritis deformans juvenilis*).

Many authors have described atrophy of the bones, and this is generally present (Fig 15), but if the arthritis is quiescent and the patient has been using the extremity for some time the bones may be of approximately normal density (Figs 16 and 17).

The characteristic rarefied areas are described by Engels<sup>20</sup> as opening into the joint with crater-like formations, but they may be deep in the bone and well removed from the joint space, and here they resemble the punched-out areas such as are produced by myeloma or metastatic carcinoma. In my cases they have been surrounded by a shell of bone which is slightly more dense than is that in the vicinity. They may be present in elbows and other joints, but are most marked in the knees.

*Diagnosis*—It is not especially difficult to arrive at a correct diagnosis if the surgeon thinks at all of the condition. The great difficulty is that the possibility of encountering a hemophilic joint does not occur to the surgeon and he may not learn that the patient is a bleeder until after the joint has been opened. At least this has been the state of affairs in most of the cases in the literature which were operated upon and died from hæmorrhage following the operation (König,<sup>1</sup> Tillmann,<sup>23</sup> Zielewicz,<sup>24</sup> Froelich,<sup>25</sup> Zesas,<sup>6</sup> and others). As a rule, these patients were orphan boys.

In my case the operation was the result of operating upon a patient after a casual examination, the diagnosis having been made by others. However, unless I had obtained a history of hemophilia I do not believe that I would have suspected a hemophilic arthritis in my case and would have operated just the same, as my knowledge of the subject was very casual until my error caused me to study it.

*In the Stage of Acute Hemarthrosis*—This is to be differentiated from traumatic synovitis, acute rheumatic fever, acute pyogenic arthritis, gonorrheal arthritis and osteomyelitis.

The most characteristic feature of an acute hemophilic hemarthrosis is the

sudden onset and rapid progress of the condition either spontaneously or after a mild injury. If the injury has been severe enough to lead the surgeon to suspect a traumatic synovitis, the swelling and effusion into the joint will occur more rapidly and will be greater than one would expect to find after such an injury and the joint capsule will be unusually tense and the patient will complain of pain even when the joint is at rest.

In acute rheumatic fever, acute pyogenic arthritis and acute osteomyelitis, the onset is more gradual and the pain is the first symptom while the swelling comes later. Likewise, in these conditions the temperature is apt to be higher,  $103^{\circ}$  or more, and the leucocyte count is usually elevated above 15,000. In hemophilic hemarthrosis the temperature and leucocyte count are as a rule only moderately elevated ( $100^{\circ}$  to  $101^{\circ}$  and 10,000 to 12,000 white blood-cells).

In all of the above conditions there is usually some increase in the local temperature, but in hemophilic hemarthrosis the skin over the involved joint is normal in temperature and color unless it has been injured, but may appear cyanotic if the joint is close to the surface, while in the other conditions there is usually more or less redness of the skin.

Gonorrhoeal arthritis resembles an acute pyogenic arthritis except that the onset is usually more gradual and the general and local symptoms are more mild in character. The gradual onset will usually distinguish it from a hemophilic hemarthrosis and in addition one may obtain either a history or physical evidence of gonorrhoea.

From what has been said above, the diagnosis may seem comparatively easy and yet if one be confronted with a flexed hip in which all motions are limited by muscle spasm and which is acutely painful, tender, and sensitive and the patient has a temperature of  $102.5^{\circ}$  F and a white blood-cell of 15,000 and gives a history of having been perfectly well the day before one is not apt to think of hemophilic hemarthrosis, which may be the condition present, and such hips have been operated upon and fatal hæmorrhages have resulted.

The most important diagnostic feature is the history, and most hemophiles know that they are bleeders and will tell the surgeon so, or their families know it and will volunteer the information and it is thus that many surgical catastrophes have been averted. As was stated above, most of the operated cases have been young orphan boys.

In any joint condition it is always advisable to inquire whether or not a similar condition ever occurred in the affected joint or in other joints. And in the hemophilic this question will usually be answered in the affirmative because most of these patients have had hemarthroses in various joints from time to time and will usually tell the surgeon that the symptoms tend to clear up after a few days' rest. Such a statement made by a pale, slender boy should always lead the surgeon to suspect and rule out hemophilia by a careful history and accurate determination of the coagulation time of the blood.

Finally, the diagnosis must be made by the history and a determination of the coagulation time of blood, and this is most accurately done by the test-tube method. However, it is to be emphasized that a normal coagulation time does not rule out hemophilia as the coagulation time undoubtedly varies from time to time in hemophiles. For instance, by the test-tube method under fifteen minutes is considered normal. In my operated case the coagulation time varied from seven and one-half to eight and one-half minutes.

In suspected cases the joint should be aspirated with a small needle and if blood is obtained and acute traumatic synovitis can be ruled out, the diagnosis of hemophilic hemarthrosis is fairly certain.

*In the Stage of Chronic Arthritis*—The symptoms may be severe or relatively mild depending upon whether or not an acute hæmorrhage has recently occurred in the joint. In the relatively quiescent state during the interim between acute attacks the joint is moderately swollen and the swelling is found to be largely the result of periarticular thickening, but the joint may also contain a small amount of excess fluid. There is no local heat or redness and the joint is not, as a rule, especially tender. There is a variable degree of flexion deformity and motion is limited, but ankylosis is not present. Function of the joint may or may not be painful and there is moderate atrophy of the muscles of the limb.

With an acute hemarthrosis the symptoms resemble those of that stage as described above. After a period of time which may last for several weeks these acute symptoms gradually subside and the joint returns to the relatively quiescent state as described above and this may last for months or years and the patient be relatively free from symptoms until a fresh hæmorrhage occurs in the joint.

The X-ray shows narrowing of the joint space, a variable amount of erosion around the articular margins and a variable amount of bone atrophy with cloudiness of the joint area due to the shadow cast by the non-bony contents of the articular capsule.

The above descriptions might serve equally well for chronic tuberculosis of the given joint and almost as well for certain low-grade monarticular arthritic conditions of traumatic or unknown etiology. As a matter of fact, most of the cases which have been operated upon were operated upon with the erroneous diagnosis of tuberculosis.

How, then, is one to differentiate the chronic hemophilic joint? An accurate history of the onset and course of the disease is the most important factor in the diagnosis. In the hemophilic joint the onset of the trouble can always be traced back to an acute swelling of the joint which may or may not have followed an injury and there will be a history of many such episodes. Usually there will have been several attacks of hemarthrosis before the true chronic arthritis began, the joint having returned to a normal condition after the earlier attacks, but occasionally, as in my operated case, the arthritis may date from the first attack. In such cases one can obtain a history of repeated acute attacks since the onset of the arthritis and the patient will state that the



acute symptoms subsided after a few days' rest And in addition to the chronic arthritis, which may be monarticular or involve two or three joints, there is a history of milder disturbances in other joints

Such a history should lead the surgeon to suspect a hemophilic joint Of course, if the surgeon should learn that the patient is a bleeder, the diagnosis is clear If there is a history of abscess formation in the joint, hemophilia may be ruled out as these joints do not suppurate

An important point in the X-ray diagnosis is that the shadow cast by the thickened synovial tissues and capsule is more dense and sharply defined than is the case with any other type of arthritis with which I am familiar However, I have seen X-rays of hemophilic arthritis of many years' standing in which the X-ray picture closely resembled that of chronic hypertrophic arthritis, and Petersen<sup>21</sup> reports cases in the hip which closely resembled old Legg-Calve-Perthes' disease (osteochondritis deformans juvenilis) The areas of rarefaction in the depths of the cancellous bone which are regarded as pathognomonic by Engels<sup>20</sup> are not always present and it should also be noted that such areas may occasionally be seen in tuberculosis or in arthritis from other causes Consequently, one must conclude that in many, and perhaps in the majority of cases the diagnosis cannot be made from the X-ray alone In my operated case the roentgenologist's diagnosis was chronic arthritis and a calcified hematoma

In case a hemophilic arthritis is suspected, the clotting time of the blood should be ascertained in order to confirm the diagnosis, but, as was stated above, this may be misleading

*Treatment of Acute Hemarthrosis*—With acute hæmorrhage into a large joint rest to the involved joint is indicated and if necessary the patient should not only be put to bed, but the joint should be splinted or even immobilized in a plaster-of-Paris bandage until pain disappears and the blood in the joint cavity is largely absorbed There is also the question as to whether or not these joints should be aspirated At times they are intensely painful and in such cases aspiration has been carried out without ill effects However, this is not a procedure without a certain amount of danger, as illustrated by the case of Petersen<sup>21</sup> in which the joint was aspirated and then continued to bleed from the puncture wound until it eventually became infected and the patient died with a streptococcus infection Consequently, if aspiration is decided upon it should be done with the full understanding on the part of the patient or the patient's parents that it is not without a certain amount of risk and the aspirating needle should be of very small bore On the other hand, in my case after operation, aspiration with a twenty-two-gauge needle was done on three separate occasions with no ill effects, but at that time in my case the blood-clotting time was within normal limits

When the swelling disappears from the joint, function may be resumed, but the patient should be cautioned against indulging in activities which would tend to result in traumatism of any sort

*Chronic Hemophilic Arthritis*—In the chronic stage of the disease the

## HEMOPHILIC ARTHRITIS

treatment may be divided into two phases (1) The correction of deformities, and (2) support of the involved joint

*Correction of Deformities*—Most of these knee-joints, and occasionally other joints develop severe deformities as in the case illustrated in Fig 13 in which the flexion contracture of both knees is beyond 90 degrees. In the majority of cases however, the deformities are not so severe. No attempt should be made to correct these deformities unless the deformity is a definite handicap to the patient. If this is true the deformity should be corrected by conservative means and operations upon the joints should not be done. In other words, the deformities may be corrected by traction or by wedging plasters or by mechanical appliances in which by means of pressure and counter-pressure with or without traction the contracted tissues are gradually stretched and the joints are straightened. After the deformities have been corrected the limb must be maintained in the corrected position over sufficient time to prevent recurrence.

*Support to the Involved Joints*—As a rule these joints are not painful except during the stage of acute disability, and no support is necessary. Occasionally however, in the case of a knee or an ankle, an elastic bandage may give the patient considerable comfort. Very rarely is a supporting splint such as a Thomas walking caliper indicated.

*Severe Haemorrhage*—In the great majority of instances the bleeding into a joint is not sufficient to materially deplete the blood volume of the patient and tends to cease spontaneously with rest. However, alarming or even fatal hæmorrhages may result from accidents or operations and subcutaneous hematoma of great size may occur spontaneously. In such cases it is imperative that the blood coagulation time be reduced to normal. There are various preparations on the market which tend to hasten the coagulation of the blood, but in a surgical emergency reliance is to be placed on a transfusion of whole blood from a matched donor. This is the method of choice as it not only reduces the coagulation time of the blood, but also restores the blood lost by the hæmorrhage.

*The Hemophilia*—At the present time we have no acceptable treatment for this condition. In a recent communication by Birch<sup>26</sup> it is shown that the failure of the blood to clot is due to an abnormal toughness of the blood platelets in that they are highly resistant to hypertonic salt solution and fail to disintegrate when the blood is shed. Since hemophilia does not occur in the female, Birch<sup>26</sup> has treated two cases with ovarian extract and has reported that the tendency to bleed has been controlled by this method for periods of eleven and five months respectively.

This is not a new idea as some years ago, while working at the Boston Children's Hospital, I administered ovarian extract to two hemophiliacs under the direction of the late Dr. James S. Stone, who was then Chief of the Surgical Service. So far as we were able to determine in our cases the ovarian extract made no difference in the condition. It is possible that we did not use the right product.

On the other hand, it should be pointed out that the degree of hemophilia varies from time to time in given patients and while the report of Birch is important and the method should be tried we reserve our opinion until further cases have been reported and these cases have been followed over a longer time. In our operated case, as stated, we were able to obtain a large increase in the number of blood platelets by the administration of irradiated ergosterol. Whether or not this increase in the number of blood platelets will result in materially shortening the clotting time has yet to be determined.

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# CONGENITAL CYSTS AND FISTULÆ OF THE NECK

By HERBERT WILLY MEYER, M D

OF NEW YORK, N Y

(CONTINUED FROM PAGE 26)

CASE REPORTS—CASE I—Miss M P, aged thirty-one, single, July, 1931 Referred by courtesy of Dr Francis Huber, Jr On the right side of her neck was a small swelling which began to be evident in October, 1930 It was very small at that time Since then

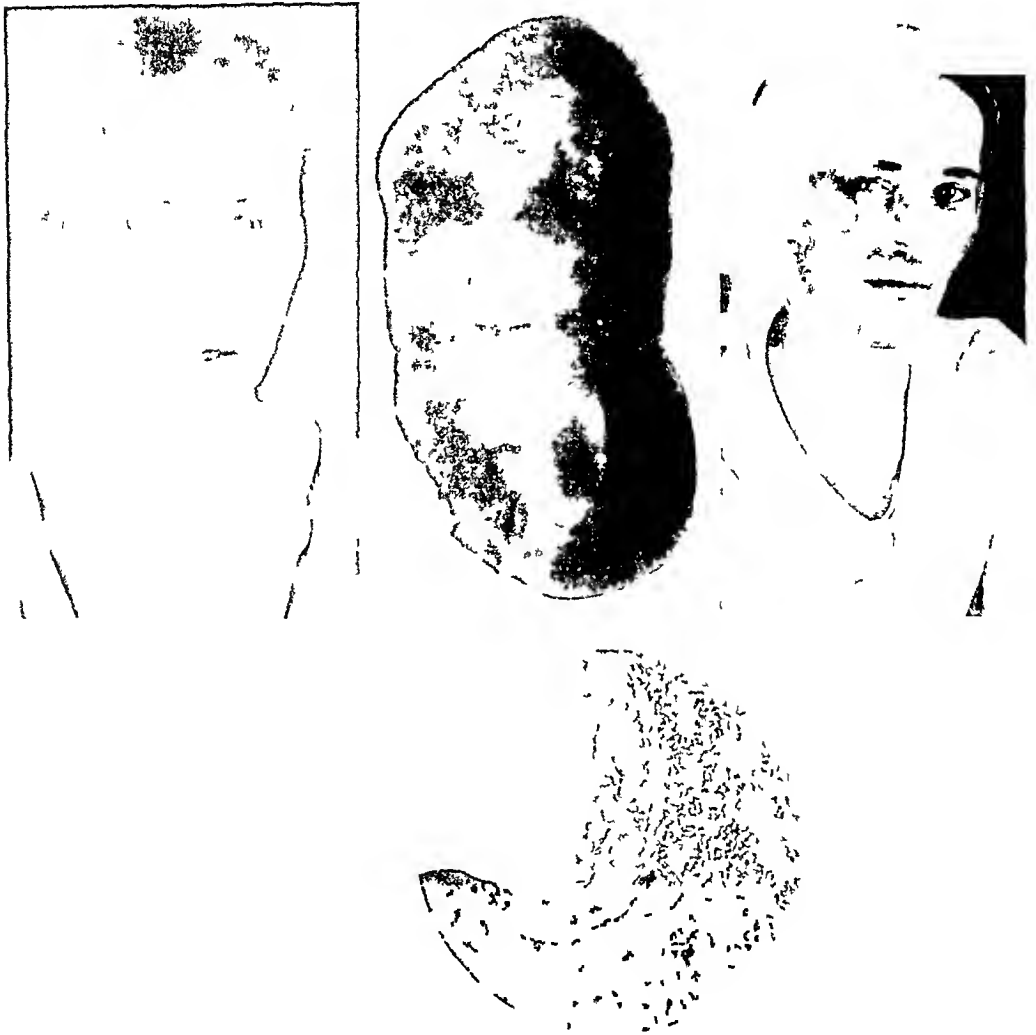


FIG 24—Author's Case I Lateral cyst of neck Showing patient before and after operation Also cyst and microphotograph of section of cyst wall with squamous epithelium lining

it had grown constantly There was no pain, no fever Family history negative All other findings negative Examination showed a cyst-like swelling about the size of a large egg, seemingly under the anterior border of the right sternocleidomastoid muscle There was no evidence of any surrounding inflammatory reaction A differential diagnosis of a tuberculous lymph-node or a lateral cyst of the neck or an aberrant thyroid cyst was made

## NECK CYSTS AND FISTULÆ

Operation was performed at the Lenox Hill Hospital July 15, 1931. A two-inch incision was made along the anterior border of the sternocleidomastoid muscle. After dividing the platysma and entering the space beneath the sternomastoid muscle, a solitary cyst was found lying external to the lateral lobe of the thyroid. It was easily enucleated and the wound closed with a small drain. Convalescence was uneventful. Microscopical examination showed the cyst to be lined with flat epithelium with lymphoid tissue in the wall. The contents of the cyst were clear. There is no question in my mind but that in this case we were dealing with a cyst which was a rest of the thymus duct, it must therefore be classified as a lateral cyst of the neck. (Fig. 24.)

CASE II—K. D., male, aged twenty-seven, May, 1925. Referred by courtesy of Dr. Emanuel Baruch. This young man had had a small opening at the lower end of the neck on the left side since the time of his birth, from which secretion had come out from time to time. It had never bothered him until five months previously when a larger swelling appeared on the left side of the neck, and the secretion that came out from the opening increased in amount and was of an extremely foul odor. When squeezing the swelling the patient noticed that the secretion also at times entered the back of his throat with a bad odor and bad taste. Otherwise he was perfectly well. General examination was entirely negative except for three sebaceous cysts of the scalp. *Local Condition*—At the lower end of the anterior border of the left sternomastoid muscle there was a small opening surrounding which the tissues were somewhat infiltrated and tender. This was the result of and had occurred within the last two days following the injection of bismuth oil to take an X-ray picture in order to outline the tract. Just above the opening of the fistula there was a swelling about the size of a hazelnut which was also moderately tender. Examination of the throat showed that both tonsils were enlarged and cryptic. Diagnosis was congenital complete lateral cyst and fistula of the neck.

Operation was performed at the Lenox Hill Hospital May 23, 1925, under general anaesthesia. An incision was made along the anterior border of the sternomastoid muscle, surrounding the fistula and including a little of the skin. The skin was reflected carefully, freeing it from below from the bismuth which had infiltrated into the tissues. The infiltrated area was treated as a tumor and removed with the cyst, which could be nicely isolated and dissected free from the underlying middle cervical fascia. After the cyst was freed the duct could be seen passing upward toward the cornu of the hyoid bone, and from here passing inward under the posterior belly of the digastric muscle. This duct was isolated as far as possible by blunt dissection from the surrounding tissues and then a clamp was placed just above the cyst. The

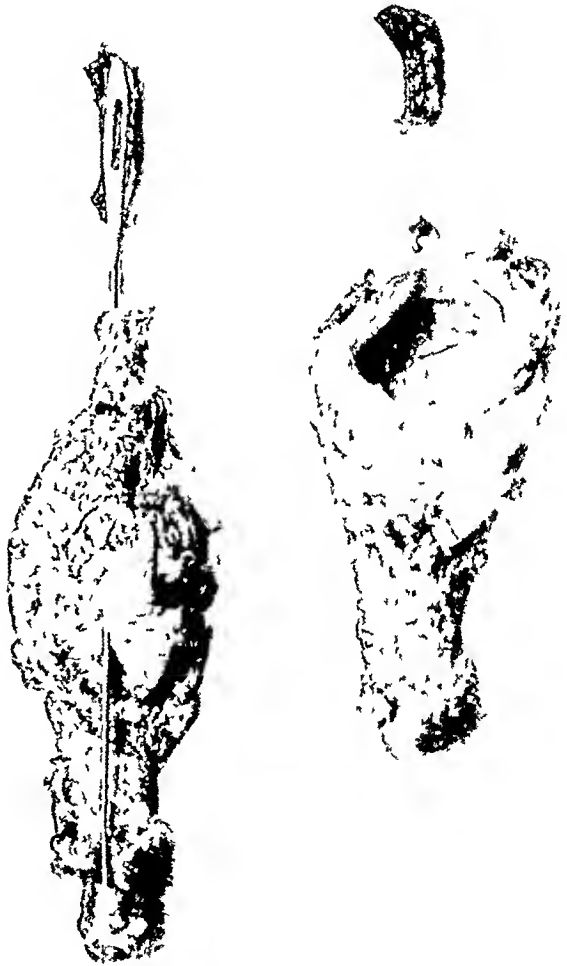


FIG. 25.—Author's Case II. Specimen of complete lateral fistula and cyst removed by operation. The inner end of duct shown as separate specimen was completely removed according to the technic of von Hacker. Picture on left shows specimen as removed; that on the right shows same specimen layed open to show lining of cyst and duct.

cyst and tumor part of the specimen were then removed. A small nick was now made into the duct permitting a probe to be introduced which, when pushed along the duct, entered the pharynx through the left tonsil close to the posterior pillar. The probe was then pulled through until the eye of the probe was within the duct. A suture was now placed through the duct, through the eye of the probe and again through the duct, and this was securely tied around the duct after pulling the probe so far that the suture would come to lie at the very upper end of the eye of the probe. The clamp was now removed and by pulling on the probe through the pharynx the entire duct was easily everted into the pharynx remaining attached to the point where it emerged through the tonsil. Here it was separated by sharp dissection and thus completely removed (Fig 25). The neck wound was disinfected with 5 per cent iodoform in ether and the wound sutured with interrupted silk. A small split rubber drain was placed in the region where the duct passed in toward the pharynx.

*Comment*—The wound healed without any trouble and the patient has remained well. From the above description there is no question in my mind but that this cyst and complete fistula exactly coincided with the course of the thymus duct, and must therefore be classified as a complete lateral fistula and cyst of the neck.

#### CONCLUSIONS

(1) Five or six arches and clefts are present in human embryos. The clefts are not open.

(2) The sinus cervicalis is bounded by the third arch, the lateral border of the neck and the chest. The second arch plays no part.

(3) The branchial apparatus lies from before backward and not from above downward. The lowest limit of the apparatus or structures that develop from it is formed by a line running through the hyoid bone.

(4) Branchial apparatus disappears in the beginning of the second embryonic month. Only squamous epithelial rests, sometimes cartilaginous rests can remain behind as parts of it. These are above and dorsal to the hyoid bone. Below the hyoid no rest of the branchial apparatus can remain behind.

(5) The thymus develops from the third pharyngeal pouch and is a long canal running obliquely from the lateral pharyngeal wall down to the sternum. Here the thymus gland substance itself begins to develop.

(6) The thymus canal retrogresses. It may persist throughout life or segments of it may persist which are usually in the lower portion.

(7) The thymus canal rests may form a fistula or a cyst. If the canal persists, a complete fistula will result.

(8) Lateral fistulae coincide with the thymus canal in direction, in histological findings, and the walls may be covered with squamous epithelium, flat epithelium, but ciliated cells may also appear.

(9) The lateral thyroid lobes also have a short lateral canal that disappears early in embryological life. It is analogous to the thymus canal and would make one believe that this canal could persist and that a fistula or cyst might develop. Inner opening would be near opening into the glottis.

#### PART II MEDIAL CYSTS AND FISTULÆ OF THE NECK

Kostanecki and Milecki were the first to clarify the massive literature on this subject. However, they made an error in that they accepted Rabl's theory, which taught

that the second cleft was very long and narrow, and served as excellent material for the development of these fistulæ. They attributed the medial fistulæ to the second branchial cleft. His disproved this theory and showed that the middle lobe of the thyroid played an important part in the formation of the mid-line cysts and fistulæ. The passage from the foramen cæcum of the tongue and the middle lobe of the thyroid was called the "ductus thyroglossus" by His. Marchand confirmed His's belief clinically by a careful autopsy of a child with a medial fistula. The fistula went upward close to the hyoid. Then it became a strand closely adherent to the periosteum of the hyoid. Close to the tongue the strand became a canal again, which opened at the foramen cæcum of the tongue.

This theory has been generally accepted by all surgeons. However, certain clinical findings, according to Wengłowski, still remained unexplained: first, the microscopical findings of the lining of the fistula, namely, once squamous epithelium, then ciliated epithelium, second, why the fistulæ sometimes pass through the hyoid bone, third, why they are never actually complete fistulæ.

In order to elucidate these three problems, Wengłowski decided to closely examine the development of the mid-thyroid lobe.

In the 26-millimetre embryo the cylindrical epithelium of the anlage in the tongue begins to grow rapidly in the form of a strand without a lumen.

In the 65-millimetre embryo the anlage is completely separated from the epithelium of the mouth and pharynx, and lies as a mass of cells in the connective tissue above the arch of the aorta. (See Fig 7.)

In the further development two processes take place. First, the anlage thickens at its lower end and is divided into two parts, one the right and one the left. On the other hand, a retrogression takes place and that portion of the anlage disappears which lies close to the epithelium of the tongue. This retrogression takes place slowly in that the strand disappears by breaking up into several portions which either entirely disappear or remain throughout life.

At the end of the second week and the beginning of the fifth week of embryonic life, this simple process is greatly complicated by the development of the hyoid bone. The hyoid bone develops from the second branchial arch, and in its growth it comes in contact with the rests of the mid-thyroid strand and divides the same into two entirely separate portions, that above it in the tongue, and that below it in front of the glottis. (Fig 26.)

For simplicity's sake Wengłowski divided his examinations and explanations of the peculiarities of this development into three portions: The tongue, the hyoid, and the infra-hyoid regions.

*The tongue portion*—The tongue develops in two entirely separate portions. The two lateral halves and tip develop from the first branchial arch and meet in the mid-line. Between these paired anlages is a small, long mass which His thought to be the single anlage of the tongue. The root of the tongue develops from the medial ends of the second and third branchial arches and the mass which lies between their medial ends is the so-called "furcula."

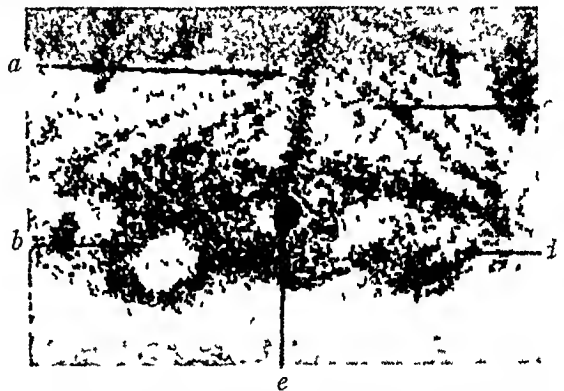


FIG 26—Cross section through hyoid region in a 25 millimetre embryo (Wengłowski). a—Tongue septum. bd—Hyoid. c—Tongue muscles.



In the microscopical examinations of the tongue in the 65-millimetre embryo, one sees that the two central elevations of the first arch go to form the anlage of the tongue, and the two side elevations form the anlage of the lower jaw. The surface of the tongue is covered with squamous epithelium which has a tendency to flatten out.

In the nineteen-millimetre embryo, just behind the thyroglossal strand rests, some clear round cells appear. This is the anlage of the body of the hyoid. As the body of the hyoid grows rapidly anterior it is the first to come in contact with the thyroglossal strand. If this strand has not completely disappeared by that time then in a great many cases it becomes deeply incorporated within the periosteum of the hyoid. As the hyoid grows farther it grows downward and forward and presses into the thyroglossal strand and divides it into two portions, which either disappear or remain for life.

In the two-months embryo the foramen cecum appears as a depression covered with squamous cells in some cases. In others it enters a canal without branches, usually lined with squamous epithelium but also at times with ciliated epithelium. The canal goes in a vertical direction and is the lingual duct. (Fig 27)

Towards the end of the second month the papillæ of the tongue, covered with

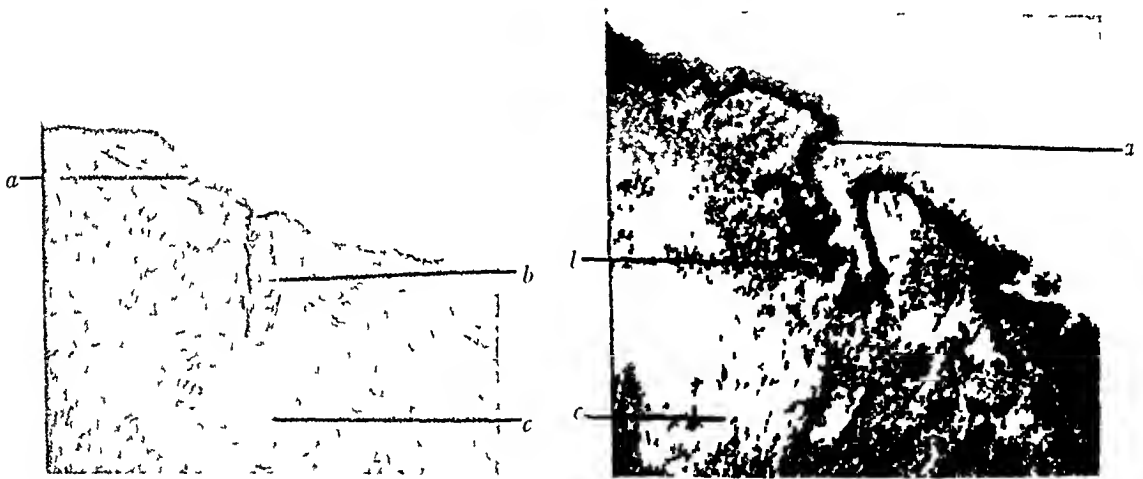


FIG 27A

FIG 27B

FIG 27A—Longitudinal section through foramen cecum in embryo beginning of second month (Wenglowski) a—Epithelium of tongue b—Lingual duct with lumen c—Tongue tissue

FIG 27B—Longitudinal section through foramen cecum in embryo at end of second month (Wenglowski) a—Foramen cecum b—Lingual duct beginning to branch c—Tongue tissue

squamous epithelium, already appear. In those cases in which the lingual duct is present, the latter appears branched with short branches. No mucous glands are to be seen. (See Fig 27)

In the third month the papillæ of the tongue are very much larger and the lingual duct, if present, has much larger branches. These branches are lined with squamous or ciliated epithelium. The direction is vertical, but more toward the tip of the tongue than backward toward the tip of the hyoid.

In the fourth month the lingual duct is larger, more branched, and lined with the same epithelium as before.

In the fifth month the lingual duct is deep and branched and surrounded in its entirety with mucous glands which pass almost to the hyoid bone. Thus it is seen that the mid-thyroid anlage has a close relation to the base of the tongue structures. The strand with which the mid-thyroid lobe connects with the tongue surface, the thyroglossal strand, either totally disappears or rests of it are to be found within the tongue substance.

In the tongue root where the anlage of the mid-thyroid lobe is pinched off, a duct remains behind. This is the lingual duct. Out of thirty embryos examined Wenglowski

found it was present only eighteen times. It is lined with squamous and ciliated epithelium (Fig 28)

At the beginning of the fourth month some of the epithelium of the floor of the mouth and the lateral outgrowths of the lingual duct can be torn away by the thyroglossal strand and be imbedded in the tongue substance, and here may form little cysts. Out of thirty embryos examined by Wenglowksi six showed these cysts. The thyroid anlage can also leave behind it thyroid rests within the tongue. These were found in four out of the thirty embryos examined.

In 117 autopsies performed by Wenglowski, the lingual duct was found in seventy-nine instances. In twenty-two it was long and not branched, and ran forward parallel to the surface of the tongue. In the others it was short, wide, and branched.

Close to the tongue its lining is mostly squamous epithelium, and in the branches frequently ciliated epithelium. The farther away from the canal the more frequently ciliated epithelium is found in the branches. However, sometimes squamous cells are found here, too. The cysts found in the root of the tongue at autopsy differ somewhat from those found in the embryos in their structure and content. The cysts at times have outgrowths passing forward into the tongue. Lymphoid tissue may be found in the

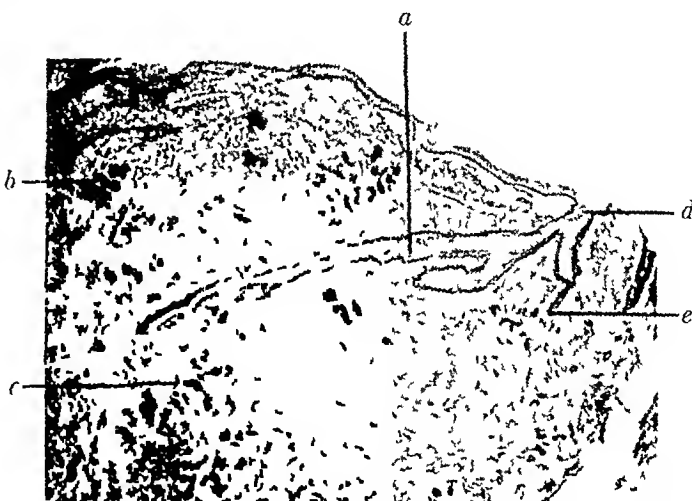


FIG 28—Longitudinal section through foramen cæcum in five months' embryo (Wenglowski) a—Lingual duct bc—Mucous glands d—Foramen cæcum e—Branch of lingual duct

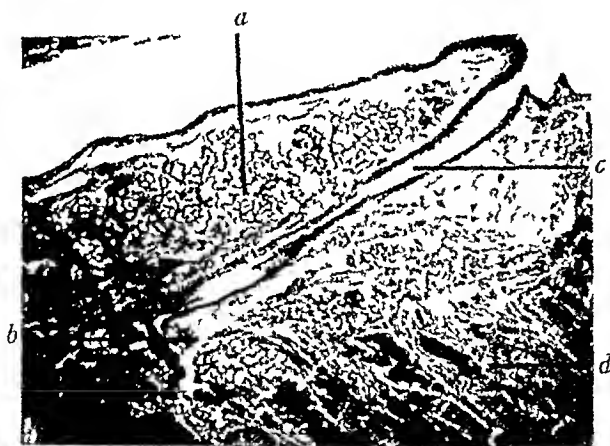


FIG 29—Longitudinal section through foramen cæcum in cadaver of child (Wenglowski) a—Mucous glands b—Branches of lingual duct c—Lingual duct d—Tongue muscles

walls, and connective tissue walls, and the lining is mixed squamous and ciliated epithelium. Mucous cysts and thyroid rests may also be found in the tongue root. They were found twenty-six times in 117 autopsies, and fourteen times thyroid rests and mucous cysts were found combined in one case (Fig 29)

*The hyoid portion*—H. Kady was the first to make more thorough examinations. Following this Zuckerkandl and Streckelsen published treatises on this subject. Wenglowski found evidences of the hyoid in the fourth week of embryonic life in the region of the second branchial arch.

Due to the close proximity of the thyroglossal strand to the hyoid, the strand undergoes complicated changes as the hyoid grows. The study of the growth of the hyoid explains these complicated changes.

At the end of the first and the beginning of the second month of embryonic life, the thyroglossal tract has a fairly straight direction. The hyoid begins behind it but has no influence upon its direction, although it has a close relation to it.

The hyoid grows downward and forward and upward and backward rapidly. It

presses against the tract and bends it. The tract is not very elastic, and where it comes into contact with the hyoid the thyroid substance first disappears and is replaced by connective tissue which is most elastic. Thus the thyroglossal tract is divided into two portions by the connective tissue band. The upper portion is on the upper surface of the hyoid, and the lower portion goes downward from the lower border of the hyoid. The connective tissue strand lies within the periosteum of the hyoid and firmly fixates the tract to the hyoid. At the beginning of the third month the shape of the body of the hyoid changes. It curves so that the upper surface takes on a convexity and the posterior surface a concavity. A horizontal ridge develops on the upper anterior surface of the convexity of the hyoid, which divides the surface into an upper and a lower portion. That portion of the thyroglossal tract at the lower border is actually pushed backward

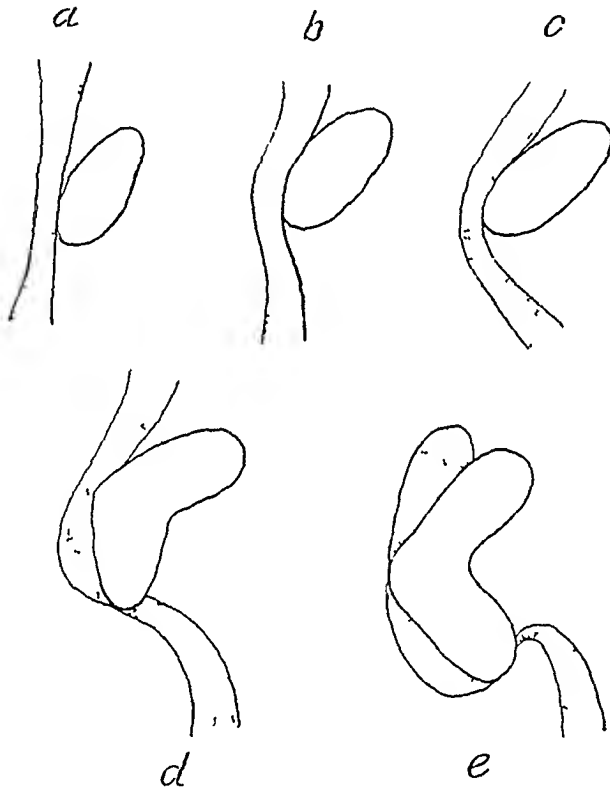


FIG. 30.—Diagrammatic sketch of relationship between thyroglossal tract and growth of hyoid bone. Stages of development of hyoid and consequent division of tract (See text) (Wenglowski)

and upward so that it comes to lie on the posterior surface. The ridge on the upper surface pushes into the tract and tends to make it obliterate at this point. The hyoid now bends at right angles at the ridge and this divides the tract into three portions. The first on the upper anterior surface of the body, the second on the lower anterior portion, and the third on the posterior surface of the hyoid. At the ridge and the lower body the tract is not to be seen in older embryos or at autopsy. Here the greatest pressure is exerted against the tract and it almost always disappears. (Fig. 30)

The most frequently persisting portion is on the posterior lower surface of the hyoid. Here it is pushed aside without any pressure against it. The next most frequent are on the upper anterior surface, and the least frequent on the lower anterior surface of the hyoid.

In Fig. 31, taken from an embryo of six months, thyroid tissue is shown on the upper anterior surface of the hyoid. It also shows the lingual duct with its branches

separate from the thyroid tissue and the remainder of the thyroglossal tract. Thyroid tissue was found by Wengłowski mostly on the upper anterior surface of the hyoid, and if this persisted through the third embryonic month, then it would persist through life. Cysts also occur, but were found only after the eighth month and may lie under the periosteum.

Occasionally the pyramidal lobe is totally absent, and occasionally accessory thyroid tissue is found in its place from the hyoid bone down to the space in front of the thyroid cartilage. No microscopical connection can be found between the pyramidal lobe and the accessory thyroid tissue. The size of the accessory thyroid tissue varies very much. If the accessory thyroid tissue is on the hyoid bone it lies either directly on it, or within the periosteum. This is the case on the upper anterior surface. If it is on the lower anterior surface it never lies within the periosteum but only touches it and is surrounded by muscle bundles or fascia.

Microscopically, the accessory thyroid tissue is quite different from the thyroid. It never has a lumen and is lined with cuboidal epithelium. It is so enclosed and bound in by fascia and muscle fibres that it has no chance to expand. This may partially explain its difference in construction from thyroid tissue. It contains no colloid. If the thyroid lies in front of the hyoid it is subdivided into several portions by muscle fibres and fascia which attach to the hyoid bone. At one end it distinctly is in contact with the periosteum of the hyoid. At the other end it distinctly lies in the muscle planes. (Fig 32)

The accessory thyroid gland within the hyoid is always accompanied by hyoid cysts. It is never found in children but in adults. These glands are surrounded by dense fibrous tissue. Within the hyoid bone they are never completely surrounded by bone but have grown into the bone marrow from within the periosteum, this actually being the direction of least resistance. The thyroid gland structure is frequently within the wall of a cyst.

Hyoid cysts can begin only in the eighth to ninth months of embryonic life. In 117 autopsies Wengłowski found them thirty-five times, thirteen simple cysts and twenty-two with thyroid tissue, in twenty-five adults, eight times simple cysts and six times with thyroid tissue, in ninety-five infants, twenty-seven simple cysts and twelve with thyroid tissue. The walls of the cyst are not always thyroid tissue. They may be mucoid glands mistaken for thyroid tissue. Usually they are not single, but there are two or three cysts. In adults they are one to one and one-half centimetres in size.

They are present on the anterior upper and anterior lower surface or within the bone. Contrary to the thyroid, the cysts are frequent at the anterior ridge of the hyoid. The hyoid atrophies as the pressure within the cyst is greater than that of the bone.



FIG 31.—Longitudinal section of tongue in six months' embryo (Wengłowski). a—Rest of thyroglossal tract b—Mucous gland lobules c—Body of hyoid d—Lingual duct. This section shows concomitant presence of thyroglossal tract and lingual duct.

Cysts of thyroid gland tissue may be in front of the hyoid, separated from it by dense tissue. Bundles of muscle fibres may be seen between the thyroid tissue and the cyst.

Wenglowski found a cyst between the periosteum and the cartilaginous hyoid in an autopsy of an infant which in later growth would erode into the narrow cavity of the hyoid. If accessory thyroid tissue is present this can be found on any surface of the cyst wall. (Fig 33)

Microscopically, these cysts have a dense fibrous layer, sometimes with mucous glands in it. The mucous glands sometimes have a duct that enters the cavity of the cyst and the glands are filled with mucoid content. These mucous glands must be distinctly separated from the thyroid glands that are not within the cyst wall but lie close to it, separated by muscle fibres or con-

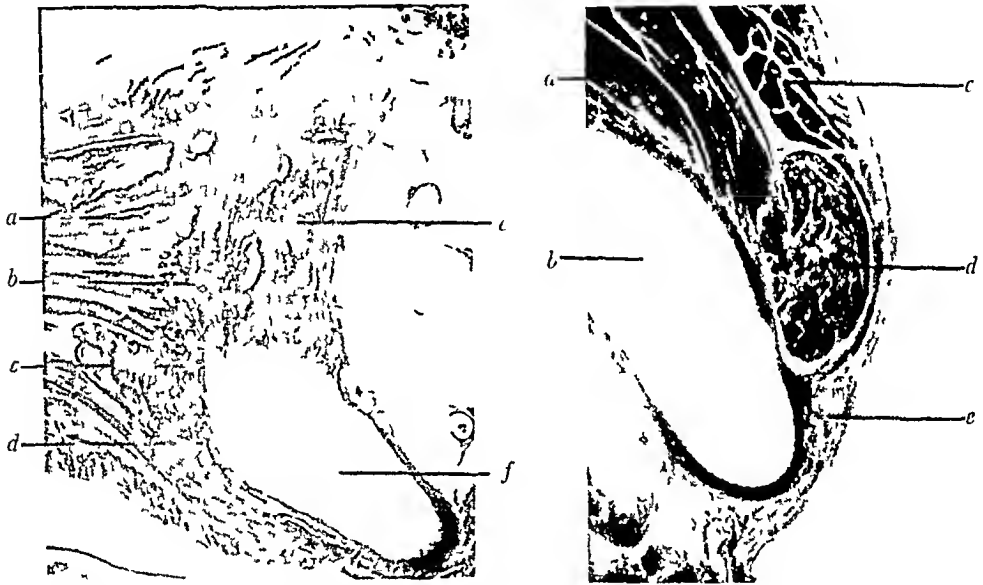


FIG 32—Left—Longitudinal section through body of hyoid (Wenglowski) a—Tongue muscles  
bcd—Rests of thyroid gland tissue ef—Body of hyoid  
Right—Longitudinal section through body of hyoid (Wenglowski) ac—Neck muscles b—Body of  
hyoid d—Thyroid gland tissue e—Tendons

nective tissue. Lymphoid tissue may also but very seldom be present in these cysts.

Sometimes the shape of these cysts is altered by outgrowths which frequently go upward into the tongue tissue. These outgrowths may be branched and multiple and some may be quite long and have a clubbed ending with mucous glands in the end of the canal. The lining of the cyst may be subdivided into first, cysts with ciliated epithelium, second cysts with squamous epithelium, third cysts with ciliated and flat epithelium, fourth, cysts with multilocular and flat epithelium, fifth, cysts without epithelium.

One point is certain namely that in the majority of cases the epithelial lining is a mixed one. The stratified squamous and ciliated epithelium is usually composed of only a few layers. Its variation and location are indefinite. The content is usually fairly thick, opaque and glaucous. Cavernous

cysts may be found in front of the hyoid and also in the pyramidal lobe of the thyroid (Fig 34)

*To summarize*—As the anlage of the middle thyroid lobe grows into the depth, not only does it alone grow into the depth, but it takes along with it the covering of the mouth cavity, namely, ciliated and squamous epithelium and all the adherent peculiarities of this epithelium, such as mucous glands, lymphoid follicles and other structures

When any of these structures have come to their resting place, they get there long before the muscles and fascia grow and attach to the hyoid bone, and if the muscles and fascia meet them as they grow toward the hyoid they either envelop them or grow through them, thereby dividing them. Further, a combat takes place in which on the one hand, these embryonal



FIG 33

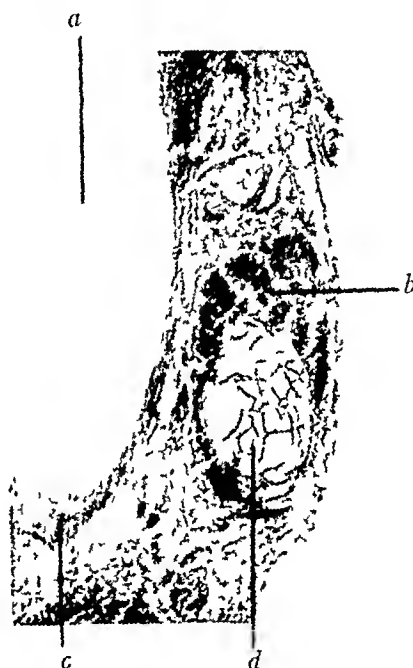


FIG 34

FIG 33—Longitudinal section through hyoid showing a cyst within the body of the hyoid bone beneath the periosteum in a craniotomy of a young child (Wenglowski) a—Body of hyoid b—Thyroid gland tissue attached to cyst c—Cyst within the bony tissue d—Thyroid gland tissue

FIG 34—Longitudinal section through the hyoid (Wenglowski) a—Hyoid b—Thyroid gland lobule d—Multilocular cyst

structures tend to grow, and on the other hand they are compressed by the surrounding structures and thereby hindered in their growth. Thyroid tissue is easily obliterated and hindered in its growth as it is tender and needs great freedom in order to enlarge and become colloid in character. The greatest freedom is at the upper anterior surface of the hyoid. The epithelial structures, however, have more power in their growth than the thyroid structures, and the epithelial cysts grow through the muscles and even erode the hyoid bone. The squamous epithelium and ciliated epithelium and mucous glands come from the neighboring mucous membrane of the tongue and are drawn down into the tongue substance by the thyroid anlage, and maintain their own original characteristics. The lingual duct is a shallow canal lined with squamous and ciliated epithelium in early embryonic life. Later it

becomes more complicated and more branched and its terminal branches are surrounded by mucous glands. Developing entirely separately from the thyroglossal tract it may co-exist at the same time, independently, as shown in Fig 31

The multilocular cysts must be looked upon as distended mucous glands, which have lost their outlet duct, and by distension have lost the mucous epithelium by pressure atrophy

*The infrahyoid region*—This region is practically the same embryonically as in later life. In 107 autopsies Wenglowski found one instance in which there was only a right lobe of the thyroid, with a total absence of any signs of a middle lobe or left lobe. One case had the left lobe missing but the middle lobe was present, and in six cases the isthmus of the thyroid was missing. The pyramidal lobe was present *in toto* or in part in seventy-nine cases, that is, 67 per cent. It was complete forty-eight times, and in thirteen instances it did not reach the hyoid but stopped at the upper level of the thyroid cartilage. If it reached the hyoid it always passed to the posterior surface of the bone. Many other variations of the pyramidal lobe were found by Wenglowski. The pyramidal lobe arises from either the right or the left portion of the isthmus, usually not from the middle portion, and passes in a pyramidal and conical form upward with the base at the isthmus. The tip of the pyramidal lobe is attached to the posterior periosteum of the hyoid with a fascial band, the lobe itself lying free. In one-third of the cases, striated muscle fibres were found scattered through the pyramidal lobe.

Microscopically, the pyramidal lobe depends upon the amount of pressure to which it is subjected or whether it is traversed by muscle fibres. Depending upon the pressure different stages of atrophy are noted. The cysts in the pyramidal lobe are mostly lined with ciliated epithelium, although, more rarely, squamous and cavernous multilocular cysts are found. These occur usually in the upper tip of the pyramidal lobe, close to the hyoid, and are mostly lined with a single layer of ciliated epithelium and are round, simple, and without prolongations. The contents are transparent and mucoid. The mixed epithelial cysts are rare and do not contain mucous glands. Multilocular cysts in the uppermost portions are more frequent than the mixed epithelial cysts.

Cysts in the lower portion of the pyramidal lobe also occur. They may be alone or combined with upper pyramidal cysts, and are lined with ciliated epithelium. The structures drawn in from the mucous membrane of the mouth by the mid-thyroid anlage are most frequently seen in the tongue portion, less frequently in the hyoid portion, and still less frequently in the infrahyoid or pyramidal region. The middle lobe thyroid anlage very easily divides into two portions which reunite close to the isthmus, so that two pyramidal lobes are present. From the fourth to sixth weeks of embryonic life these pyramidal lobes usually retrogress and disappear, although some vestige of them is to be found close to the isthmus. One or the other may persist. Usually the left one persists.

The region in the adult where this division of the mid-thyroid anlage takes place is in the lower half of the hyoid body. Cases have been observed where this division has taken place lower down. They unite at the lower border of the hyoid and at the isthmus of the thyroid.

*Clinical Observations*—Two types of mid-line cysts are found pathologically in life: (a) Epithelial tubes or cysts with simple or complicated structure of the walls, and (b) thyroid tissue rests. The first group creates the mid-line fistulae or cysts, the latter causes a goitre at abnormal locations. No canal or complete fistula can exist. In spite of this many authors still accept the theory that the mid-line fistulae are rests of the thyroglossal duct which should be called, by rights, the thyroglossal tract. It was usually believed that the reason the tract was not complete was that the hyoid grew into the

duct and obliterated it. Most of the mid-line fistulæ end at the hyoid, and this was thus erroneously explained.

In 1892, Marchand dissected a duct up to the hyoid bone, separated it from the periosteum to which it was tightly adherent and then dissected out a thickened strand to the foramen cæcum. He thought the duct had been obliterated but had previously been present. In the thickened strand passing through the tongue Wenglowksi never found evidence of the thyroglossal duct. There are some cases in which the mid-line fistulæ do not touch the hyoid and pass upward above the hyoid, there to end blindly, never to go all the way to the foramen cæcum. These fistulæ are formed from the so-called Bogdalek canal.

The accepted theory was that the cysts or fistulæ of a thyroglossal tract would have to be lined with ciliated epithelium, but one finds squamous epithelium in many cases. The squamous epithelium found was explained by the squamous epithelium growing into the tract from the tongue and into the duct from the skin at the fistula opening. Microscopical examinations proved this theory to be erroneous. In the simple cysts alone one finds squamous or ciliated or mixed epithelium. This, of course, cannot come from the neighboring tongue structures nor from the tissues around the fistulous opening. Squamous cells found in a section are always the rests of a cyst or one of its processes that always contain well-preserved epithelium.

Only in the two- to three-millimetre embryos is the thyroid anlage covered with epithelium. After this, as it grows downward, the epithelium disappears.

How, then, do the cysts and fistulæ develop?

Along the entire mid-thyroid anlage there are groups of different types of epithelium which occur in well-developed embryos and cadavers as cysts. *This epithelium does not arise from a thyroglossal duct*, as the latter duct does not exist, but it arises from the mouth cavity epithelium which is mechanically torn into the tissues by the thyroid anlage in its rapid growth and remains in different degrees of distension.

In very young embryos the mouth cavity is lined with squamous epithelium and with ciliated epithelium admixed. The ciliated epithelium is most frequently found in the region of the furcula, the base of the tongue, where the thyroid anlage arises. This explains why the epithelium pulled into the depth may be of different types, and that it is pulled in is shown by the finding that the farther one gets away from the tongue surface the more infrequent are the epithelial rests found, until they totally disappear. The epithelium maintains its inherent characteristics and later becomes surrounded with connective tissue and forms a cyst. In the cysts, as in the mouth cavity, acinous mucous glands develop and lymphoid tissue, *etc*. This process has no correlation with the development of the thyroid anlage.

As these cysts often contain lymphoid structure in the wall and due to other causes they can become infected and inflamed, they then grow rapidly to quite a size and open externally and spontaneously. A fistula develops due to the epithelial lining which causes a persistent fistula with secretion, incurable by itself.

The age at which these cysts and fistulæ develop is uncertain. From fifteen to thirty years is the most frequent age. They are never present at birth.

The fistula develops by the suppuration of the cyst, adhesion to the skin and perforation. This may occur from the lower jaw to the sternum in the mid-line, dependent on where the skin becomes adherent. The cyst is almost always in close connection with the hyoid, except those which lie above the hyoid and within the root of the tongue which may cause the formation of a fistula.

The lumen of the fistula ends with the hyoid or a depression in it. It never passes through the bone. In the strand above the hyoid running to the foramen cæcum an epithelial-lined lumen is never found.

Microscopically, the mid-line fistulæ are branched and one finds one larger lumen surrounded by several smaller ones. The difference between the lateral and mid-line fistulæ is that in the mid-line a great number of fistulæ can be found similar almost to



the structure of an adenoma. The explanation is that the original cyst which existed previous to the development of the fistula was distended by its content and had several processes passing into the surrounding tissues. The smooth lining of the cyst after the collapse became corrugated and snake-like and branched, and gives the picture of several lumina. Not only the main lumina but several of the pockets are cut across at various levels (Fig 35)

The lumen of the fistulae and cysts is mostly cylindrical covered with little cilia, but admixture of squamous and ciliated epithelium may be found. Rarely are purely squamous-cell linings found. The ciliated epithelial-lined cysts have two to three layers of cells. Within the wall there is round-cell infiltration. The cysts can occur below the hyoid, above it, and within the tongue substance, and may grow externally and internally into the mouth cavity. The small cysts situated near and around the hyoid may develop into pathological mid-line cysts and fistulae of the neck. They maintain their histology. The close adhesion to the hyoid is a characteristic of the "normal



FIG. 35.—Cross section through a median fistula showing microphotograph of several lumina of fistula. This is caused by the collapse of the cyst, which had several processes, upon the rupture of the cyst and consequent development of a fistula. This collapse gives the inside lining of the cyst a corrugated appearance which on cross section therefore shows several lumina. *a*—Thyroid gland lobule. *bd*—Lumina of fistula. *c*—Ciliated epithelium of fistula.

cysts" in this region. The cysts have no relation to the thyroglossal duct, as this is only a hypothetical duct and in actuality does not exist.

The fistulae may arise from either pyramidal lobe, and the number of fistulae may depend on how many of the "normal cysts" may be present and develop into pathological cysts. Recurrences of fistulae may be due not to an incomplete operation but may be a cropping up of a further "normal cyst" that had previously not been enlarged, but which secondarily and later had become inflamed and then enlarged and broken through the old scar, the place of least resistance.

*Treatment*—Complete operation for the cure of this condition means the complete removal of all epithelial tissue in connection with the fistulae. The mid-portion of the hyoid bone should be removed. In the strand that goes from the hyoid to the foramen cæcum epithelial nests and thyroid-gland tissue may be present, and therefore, in order to effect a complete cure it is wise to remove this also.

In the October, 1921, issue of the Surgical Clinics of North America

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Dr Walter E Sistrunk, of the Mayo Clinic, published some very illuminating pictures which showed the principles of this radical operation which would be most apt to effect a cure. Dr Edwin Beer at that time suggested a similar procedure. Older surgeons also followed similar plans. The operation is performed through a transverse incision across the neck at the level of the hyoid bone. The skin and platysma muscles are reflected. The cyst is usually found lying between the raphe connecting the sternohyoid muscles.

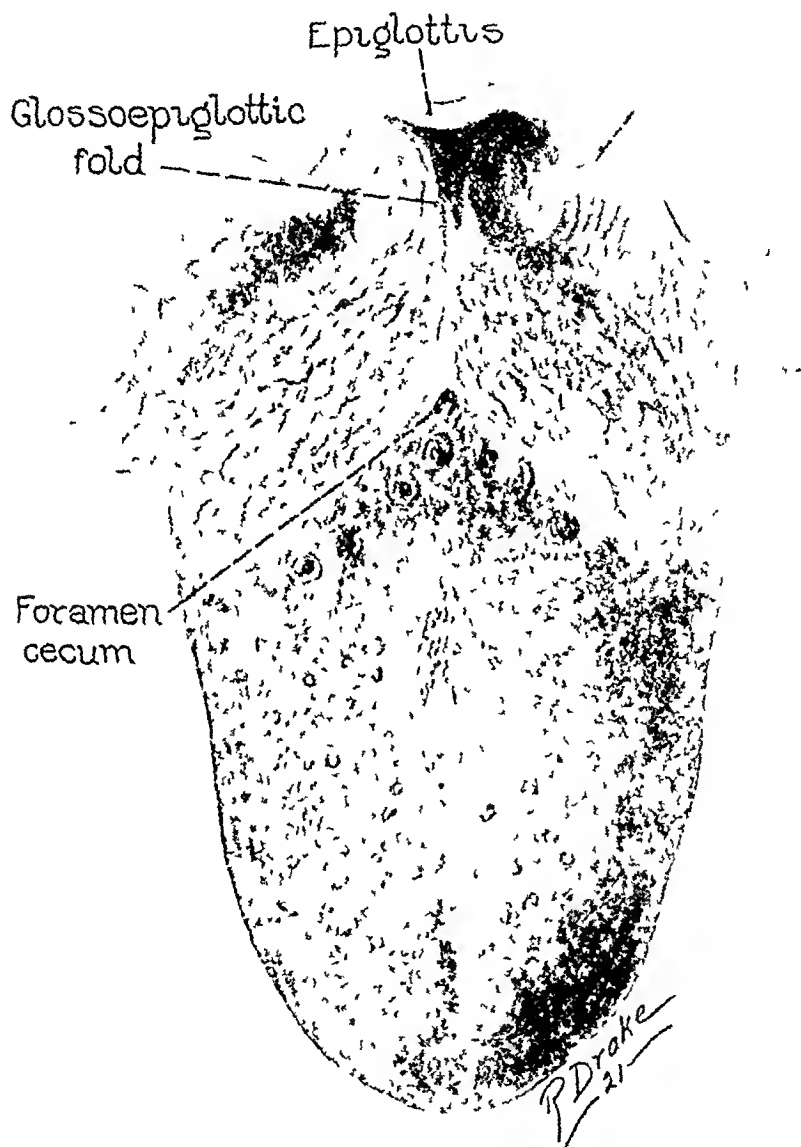


FIG. 36.—Diagrammatic drawing of upper surface of tongue showing foramen cecum and circumvallate papillæ (Sistrunk.)

It is dissected free up to the hyoid bone. At this point the tract is firmly attached to the hyoid. The muscles are separated from the centre of the hyoid bone, and about a little less than half a centimetre of the bone is removed. Then, without any attempt to isolate the strand running to the foramen cæcum, the tissues are coiled out from this point directly to the foramen cæcum, taking along the strand with the tissues surrounding it for a distance of about 0.3 centimetres on either side. In doing this it is

necessary to keep clearly in mind the direction of the foramen cæcum. This corresponds to a line drawn at an angle of  $45^{\circ}$  backward and upward through the right-angle intersection of lines drawn horizontal and perpendicular to the superior central portion of the hyoid bone. In the dissection of the strand, a portion of the hyoid bone, a portion of the raphe joining the mylohyoid muscles, a portion of each of the geniohyoglossus muscles, and the

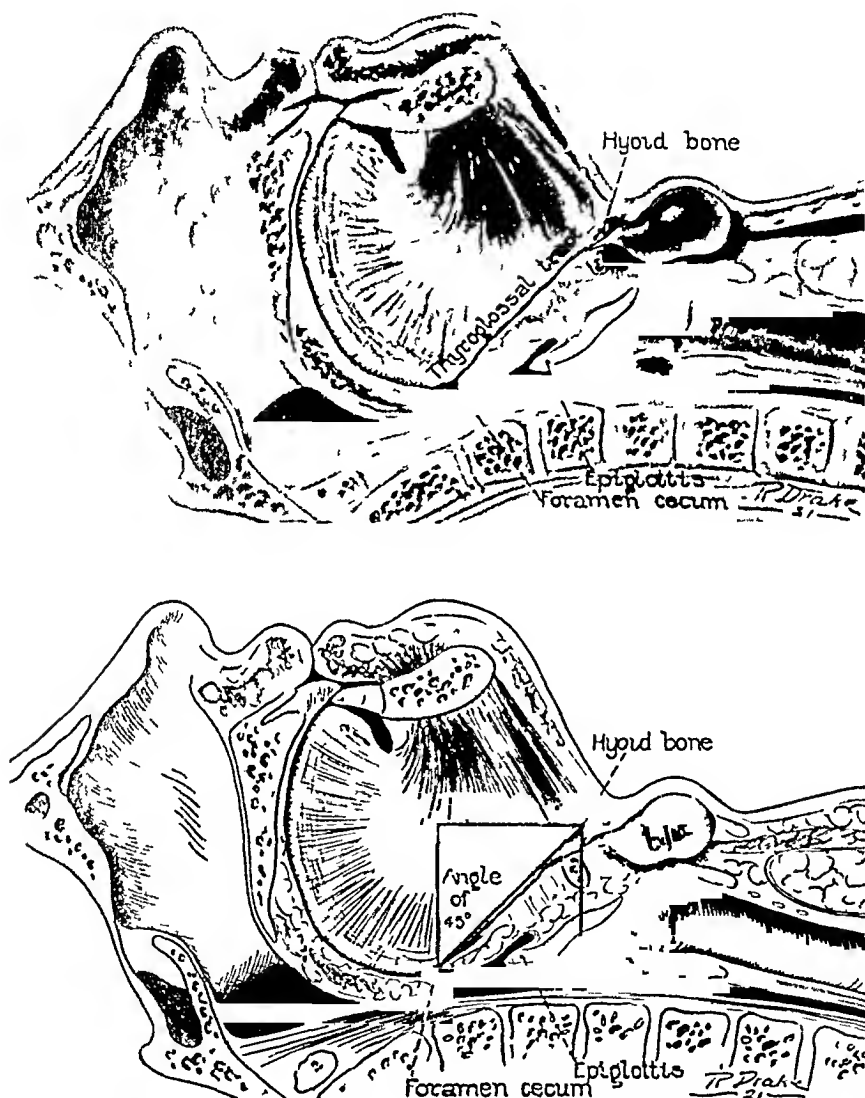


FIG 37—Diagrammatic drawing showing relation of cyst and course of the thyroglossal tract to hyoid and tongue structures. Lower drawing shows principle underlying technic of total removal of the tract. (See text.) (Sistrunk.)

foramen cæcum are removed. The opening in the mouth is closed and the geniohyoglossus muscles are drawn together with interrupted catgut sutures. If desired the dissection may be stopped just before reaching the foramen cæcum, thus not opening into the pharynx. The tissues surrounding the cut ends of the hyoid bone are either brought together with chromic catgut

sutures in such a manner as to approximate the edges of the bone, or they may even be left separated. A small rubber tube, and preferably, also, a small tampon are introduced down to this point, and the skin is closed. (Figs 36, 37)

**CASE REPORTS**—In giving these case reports I shall give only a very short abstract of nine of these cases as they were all operated upon identically, and I shall describe only one case in detail in order to avoid repetition.

**CASE I**—M K, seven-year-old boy, admitted to the service of Dr George H Semken, at the N Y Skin and Cancer Hospital, with a recurrent thyroglossal fistula just below the hyoid bone. Operated on December 16, 1921, with the total excision of the fistula, portion of the hyoid bone and coring out of the tract from the hyoid to the foramen cæcum. Uneventful recovery with cure of condition.

**CASE II**—D H, fifteen-year-old girl, admitted to Doctor Semken's service at the Skin and Cancer Hospital and operated on December 20, 1922. She had had three previous local operations with three recurrences. Radical operation was performed with excision of the entire tract from skin fistula to foramen cæcum and patient seen eight years later was entirely well.

**CASE III**—J C, fifty-three-year-old man, who noticed swelling six months previously. This was incised and developed into a fistula. Was admitted to the service of Dr Willy Meyer, at the Lenox Hill Hospital, and operated on in May, 1922, under colonic anæsthesia. The operation was performed as usual and was uneventful. Two hours after the operation the patient died and autopsy did not reveal any cause of death, but it was attributed to the probable falling back of the patient's tongue while still under the effects of the colonic anæsthesia and death by suffocation. The operative field was negative.

**CASE IV**—T M, twenty-three-year-old man, admitted to the service of Doctor Semken, at the N Y Skin and Cancer Hospital, with a recurrent thyroglossal fistula. Operated under colonic anæsthesia on October 30, 1923, with total excision of the tract with a portion of the hyoid bone. Uneventful recovery and cure.

**CASE V**—K McQ, twenty-two-year-old girl, admitted to the service of Dr Carl Eggers, at the Lenox Hill Hospital, with a recurrent thyroglossal fistula that had been operated on elsewhere one and one-half years before. Radical operation with excision of a portion of the hyoid bone in May, 1924, under colonic anæsthesia. Uneventful recovery and healing. Five months later a small cyst developed at the angle of the scar. This was curetted and patient has remained well to date. This is probably one of those cases where a new cyst developed from epithelial rests that enlarged subsequent to the first radical operation.

**CASE VI**—S S, four-year-old boy, admitted to the service of Doctor Semken, at the N Y Skin and Cancer Hospital. Operated on October 7, 1924, under general anæsthesia. Uneventful recovery and entirely well when seen two years later.

**CASE VII**—T G, eight-year-old boy, admitted to Doctor Semken's service at the N Y Skin and Cancer Hospital. Operated on December 10, 1927, after previous operation elsewhere. Typical operation with uneventful recovery.

**CASE VIII**—W R, seven-year-old boy, referred to me by Dr John D Kernan and operated on in November, 1928, at the Lenox Hill Hospital on Doctor Kernan's service. This boy had also had a previous operation with a subsequent recurrence of a cyst just above the previous scar. Typical complete operation from skin to foramen cæcum with removal of a portion of the hyoid bone. Uneventful recovery and cure. (Fig 38)

CASE IX—M G, ten-year-old boy, admitted to the service of Doctor Semken, at the N Y Skin and Cancer Hospital, with a recurrent thyroglossal fistula. Radical operation under general anæsthesia on October 26, 1928. Uneventful recovery and well to date.

CASE X—Mrs A V R, a lady thirty-nine years of age, referred by the late Dr McKelvey Bell, suffering from a recurrent thyroglossal fistula. Eight years previous following a severe attack of grippe a swelling rapidly developed in the mid-line of the neck just below the level of the hyoid bone. Was operated upon by the late Dr Charles N Dowd, of the Roosevelt Hospital, in 1917. Wound did not close. Later treated in Washington, D C, with carbolic acid and the wound closed and remained closed for two years. In December, 1919, had pain in throat again and swelling developed. Was operated on at that time under local anæsthesia. Closed but recurred in September, 1925. In November, 1925, was again operated upon by Doctor Dowd, who this time is said to have gone through to the mouth. From that time on the wound remained open. The patient was entirely well except for a fistula in the mid-line just below the level of the hyoid bone.



FIG 38—Author's Case VIII. Showing patient with recurrent cyst before and after operation. Also typical specimen removed, the cyst section of hyoid and tissue cored out through tongue representing strand running to foramen cecum.

There was a pin-point opening from which a very slight non-odorous discharge appeared. Probe did not enter it. Bismuth injection showed a branched tract passing above the hyoid bone. Just before operation Doctor Bell was kind enough to inject the fistula with a solution of methylene blue.

Operation at the Lenox Hill Hospital on November 4, 1926, under colonic ether-oil anæsthesia. An ellipse of skin was excised over the region of the hyoid bone surrounding the previous operative scar and fistulous opening. Skin was then reflected exposing the platysma muscle. This was then incised, bringing the incision down to the deeper structures. The operation was then continued according to landmarks. All of the old scar tissue and fascia was dissected upward from over the thyroid cartilage to the hyoid bone above. Similarly, the scar tissue from previous operations was dissected downward from the sub-mental space to the hyoid bone, exposing the mylohyoid muscle as the floor of the field. Laterally, the tissues were dissected medially on either side beginning at the border of the sub-maxillary salivary gland and sweeping across the hyoid bone and leaving all of the tissue attached to the hyoid bone. A portion of the centre of the hyoid bone a bit over one-quarter inch in length was then excised and the thickened tissue strand was then cored out in a direction through the tongue muscles corresponding to a line drawn at 45° through a right angle formed by a line horizontally passing upward.

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at the anterior border of the hyoid bone and a line dropped vertically to the spinal column from the lower border of the hyoid bone. This dissection was carried down through the mylohyoid muscle and the genio-hyoglossus muscle to the mucous membrane at the foramen cæcum, which was also removed. Here, in this region, for the first time,



FIG. 39—Author's Case X. Showing patient with fistulous opening in centre of previous operative scar and patient following operation with total removal. Also (left) specimen, anterior view and (right) posterior view of specimen showing cyst, section of hyoid and strand running to foramen cæcum which is also visible. (See text.)

some of the methylene blue injected before operation was seen. The tongue wound was then thoroughly cauterized with the Paquelin cautery and disinfected with 5 per cent iodoform in ether. The tongue was reconstructed by suturing the hyoglossus muscle with

No 00 chromic sutures Two split drains and a small iodoform tampon were placed into the space between the hyoid bone On account of the previous operations the hyoid ends in this instance were not approximated The platysma was separately sutured with No 00 chromic catgut interrupted sutures The skin was closed with interrupted black silk The convalescence was uneventful except for the fact that each of the chromic catgut knots placed in the platysma was discharged through the skin wound, probably explained by the poor circulation and absorptive power on account of the three previous operations In another instance I would use plain catgut instead of chromic catgut Otherwise, the wound healed, and there has been no further trouble to date, which is five years post-operative (Fig 39)

#### CONCLUSIONS

(1) The mid-thyroid anlage develops from the epithelium of the floor of the mouth as a thick-celled strand without lumen

(2) The anlage in its rapid growth drags surrounding cells into the depth of the mesenchyme

(3) The inherent embryonal characteristics continue in these epithelial rests as they do in the mouth, and they can grow and develop, but being surrounded with the surrounding tissues they can change into different types of cysts

(4) The thyroid anlage divides into two halves, the unpaired part of the thyroglossal tract retrogresses and either totally or partially disappears

(5) The hyoid bone develops in the fourth to fifth week The body of the hyoid comes in close contact with the already well-developed thyroglossal tract

(6) The body of the hyoid presses into the tract, injures it, subdivides it at certain points and changes its direction

(7) The retained rests of the mid-thyroid anlage are epithelial structures from the floor of the mouth and are spread out between the foramen cæcum and the mid-thyroid anlage

(8) They are most frequent in the root of the tongue and the hyoid, and rarer the nearer one comes to the mid-thyroid anlage

(9) The thyroid particles usually remain as atrophic parts of the gland The epithelial rests change into cysts which are lined with ciliated, squamous and mixed epithelium

(10) In pathological conditions thyroid particles can develop into goitres The "normal cysts" can develop into pathological medial cysts and fistulæ

(11) A duct does not occur, only a tract, and it plays no part in the formation of cysts or fistulæ These come from the mouth epithelium dragged in, which may form a "normal cyst" An incomplete fistula can occur, but not a complete one

(12) The foramen cæcum is a remainder of the spot where the anlage developed The lingual duct is not a part of the thyroglossal tract, but develops from the mouth epithelium which has been dragged in It develops at a later time Therefore, its form and direction are not always the same In young embryos it has no processes, but may have many in older embryos The tract and lingual duct may occur together

## NECK CYSTS AND FISTULÆ

(13) The tongue cysts develop from the pinched-off processes of the lingual duct

(14) The radical cure of these conditions necessitates the complete removal of the cyst, the hyoid bone, and those tissues running from the hyoid bone to the foramen cæcum

### PART III

There are still a few pathological conditions that have to be mentioned in order to complete the congenital conditions that may occur in the neck but which do not fall into the classifications of lateral or medial cysts or fistulæ of the neck. These are well described in Dr. Semken's article in Nelson's Loose Leaf Surgery from which the following facts are taken

**SUBLINGUAL AND SUBMAXILLARY CYSTS**—The mesobranchial field lies between the ventral ends of the branchial arches as they grow forward to unite ventrally. The anterior portion of the tongue and floor of the mouth is formed in this field from the anlage of the first branchial arch. This is from one process of the arch, from the other process the lower jaw is formed

Many inclusions of epithelial cell groups may occur here and form cysts

If they occur in the mid-line and in the suprahyoid region they are usually thyroglossal cysts, if lateral they are true branchiogenetic cysts, and if in the sublingual region they are epithelial rests in the mesobranchial field. These may grow into the sub-maxillary region but have no relation genetically with a ranula

Rarely they cause mechanical disturbance and are easily removed surgically

**CYSTIC HYGROMA OF THE NECK**—*Embryology*—In mammals the lymphatic system begins in the neck in the two jugular sacs on either side near the junction of the internal jugular and subclavian vein. Small veins, branches of the internal jugular, get rid of the blood, separate from the vein and coalesce to form sacs. Thus the lymphatic system is derived from the venous system. Later the lymphatic vessels join the vein again and empty into them. Finally they develop into the important primary groups of lymph-nodes. They take a prominent part in the development of the entire lymphatic system

Two jugular and two subclavian sacs are joined in the human into one but this fact explains the extension of the later pathological lymphatic structures extending upward into the neck and downward under the clavicle

The histology is that the hygromas have a fibrous wall with lymphatic follicles in it and lined with endothelial cells. The cystic hygromas apparently arise in these vestigial remnants of this tissue

*Clinical conditions*—The hygromas occur essentially in early childhood. At birth there is a soft swelling at the outer border of the sternomastoid muscle just above the clavicle with one-quarter below the clavicle. They are quiescent until they are stirred into rapid growth by an infection or



childhood disease The hygromas are soft and elastic with few symptoms and push the vessels and nerves aside in their expansile growth

*Pathological anatomy*—Unilocular and multilocular cysts may occur They have a thin, firm wall with smooth endothelial lining In inflammatory conditions granulation tissue may replace the lining The contents are a thin serous fluid which may be admixed with blood and in infection this may be changed into pus

*Differential diagnosis*—This rests between lipoma, lateral cyst of the neck, lymphangioma and aberrant thyroid

*Treatment*—Operations are dangerous for this condition on account of the youth of the patients and the extension into regions difficult of access Injections are of no value as the hygromas are usually multilocular X-ray and radium is of great value In cases suitable for surgery excision is the method of choice The skin and platysma are cut with the outer layer of the middle cervical fascia The landmarks are the vessels and nerves and the wall of the cyst Total careful removal is essential Post-operative irradiation is of value If not totally removed recurrence is rapid If the hygroma passes into the axilla complete division of the pectoralis major with later resuture is necessary

LYMPHANGIOMATA OF THE NECK—The lymphangiomata arise in the congenital defects in the development of the lymphatic vascular system They are derived from the capillary vessel primordia while the cystic hygroma develop from the larger jugular sacs

They may be simple, cavernous or cystic

*Pathological anatomy*—The simple angiomata are dilated vessels not sharply defined from the neighboring lymph-vessels are circumscribed or diffuse occurring in the skin and subcutaneous tissue of the face and neck They are partly effaced by pressure Skin blebs may occur

The cavernous type are large spaces with a single layer of endothelial lining Between the spaces is cellular tissue in larger or smaller amount in which many lymphocytes and some lymph follicles may be found They are larger in size, semi-fluctuating tumors, flabby, and smooth or firm, and slightly nodular In the neck they occur in the skin or subcutaneous tissue and may have finger-like processes that grow into the depth and push structures aside, but do not invade them They can be partly effaced by pressure

The cystic lymphangiomata are collections of small cyst-like vesicles with some proliferative changes in the stroma found in the cavernous type They contain clear fluid, occasionally turbid The cystic type may be large tumors in the neck, axilla, chest, beneath the skin, usually beneath the fascia, more or less separated from the surrounding tissues with which they have no intimate connection by way of the lymphatic channels An angiomatous condition may accompany them

They represent the only benign tumors of the lymphatic system, occur in

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childhood, and are slow-growing, present no symptoms and may be covered with blebs and have an inflammation ingrafted upon them

*Treatment*—The effect of irradiation is that of obliteration. For the cavernous and cystic type with fibrous proliferation surgery is indicated. Around and underneath the tumors an injection should be made with 1:30,000 adrenalin (epinephrin) solution to control bleeding. Suspicious areas must be carefully removed from the under surface of the skin flaps with scissors. The deep cavernous types must be carefully removed, dissecting by landmarks. Operation should be followed by irradiation.

**HÆMANGIOMA OF THE NECK**—These occur cutaneous and subcutaneous and originate from small vessels and capillaries as the lymphangiomata do. Surgery with the previous injection of adrenalin and removal with ligation of the feeding vessels is the method of choice in treatment.

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# COMPARATIVE STUDY OF ANTISEPTICS IN EXPERIMENTALLY PRODUCED LOCAL INFECTIONS

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A HOST of germicidal compounds have been introduced during the past few years for local treatment of infected wounds and ulcers and for application to the unbroken skin and mucous membranes as disinfectants

Most of them are complex organic compounds and many depend upon mercury or combinations of this metal with dyes for their germicidal action

Kolmer states that an acceptable compound should (a) kill all pathogenical organisms or greatly reduce their numbers, (b) act within a period of five minutes, (c) penetrate epithelial cells, (d) dry rapidly, but not too rapidly, (e) stain sufficiently to mark off the area, (f) be free of undue irritation, especially when used on mucous membranes, (g) be of low toxicity, and (h) not be precipitated by the proteins of the blood, exudation, pus, etc

The object of this study was to determine what antiseptic could be recommended for use in the average hospital clinic and by the practicing physician in the treatment of local infections. Most local infections seen in surgical clinics are caused by the staphylococcus group and associated pus producing microorganisms, and for this reason we selected those germicides for which are claimed selective activity against these microorganisms. Also, we used those most popular among physicians and the laity, such as mercurochrome, mercurophen, metaphen, and tincture of iodine. It will be noted that the first three are mercurials.

As this paper is not a critical review but a statement of our results, it suffices to mention only a few of the more recent publications.

Since the introduction of mercurochrome by Young and his associates, who claim unusual antiseptic properties for the compound in almost every field of medicine, numerous articles have appeared, both favorable and unfavorable.

Walker and Sweeney,<sup>1</sup> in a comparative study of mercurochrome, gentian violet and acriflavin injected intraperitoneally and applied subcutaneously in staphylococcus and streptococcus infections in mice, report that each product has its field of usefulness.

Colebrook and Hare<sup>2</sup> report that the bactericidal properties of human serum treated with mercurochrome are less than those of the untreated serum for staphylococcus and streptococcus. Similar observations were also made on the bactericidal properties of rabbit sera for *Bacillus typhosus*.

Sanner and Hill,<sup>3</sup> Scott and associates,<sup>4</sup> Reddish and Drake,<sup>5</sup> all report favorable results with mercurochrome applied locally, intravenously and intraperitoneally in experimental infections.

On the other hand, Simmons<sup>6</sup> and also Rodriguez<sup>7</sup> concluded that mercurochrome

is not effective as an antiseptic on the unbroken skin and unbroken mucous membrane. Both of these workers found tincture of iodine more efficient.

Douglas and his co-workers<sup>8</sup> tested the effect of mercurochrome upon local infection in the leg of dogs by injection into the femoral artery. They observed no difference between the treated and untreated animals.

While the reports in the literature on mercurphen and metaphen are not so numerous as those on mercurochrome, the few articles available report these germicides as efficient especially for local application to which their use has been almost entirely confined. The recent work of Raiziss, Severac and Moetsch,<sup>9</sup> reporting metaphen 100 per cent efficient as a skin germicide, has been questioned by White and Hill<sup>10</sup> as they were unable to confirm their results. However, Raiziss and his associates have since confirmed their original findings (unpublished report).

The plan of our experiments was to produce in guinea-pigs local abscesses with a recently isolated culture of staphylococcus aureus. The hair of the abdomen was removed, a small transverse incision made in the skin and a subcutaneous pocket produced. This pocket was packed with aleuronat moistened to the consistency of a paste with a twenty-four-hour culture of the staphylococcus.\*

Within seventy-two hours all the guinea-pigs developed abscesses. They were then divided into several groups and treatment with the various germicides commenced. This consisted of removal of the scab which formed over the incision, liberation of pus by gentle pressure and application of the germicidal compound with a cotton applicator. This was repeated once daily. No attempt was made to protect the abscess in the interval of treatment. Daily observations of the gross appearance of the lesion was noted, degree of healing, the character and amount of pus, and in some instances the presence or absence of microorganisms.

The experiments were repeated three times, following the same procedure.

All compounds used were purchased in the market, except the tincture of iodine, which was prepared according to the official method.

The first experiment comprised five groups each of four guinea-pigs. After abscess production they were treated with mercurochrome 2 per cent aqueous solution, mercurphen 2 per cent aqueous solution, metaphen, 1:500 (as purchased), and tincture of iodine.

The second series was identical with the first except for an additional group treated with mercurphen, 1:500 dilution.

In the third series we substituted mercurphen 1 per cent solution, for the tincture of iodine, for reasons stated below.

## RESULTS

We observed that all the abscesses in the 1 and 2 per cent mercurphen treated animals were healed in a maximum time of eleven days. The metaphen 1:500 solution, and the tincture of iodine, treated animals required fifteen days for complete healing. One animal treated with tincture of iodine

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\* Aleuronat appears to be the only substance which when mixed with staphylococcus, will produce abscesses in the lower animals with any degree of uniformity. We have tried powdered peptone, pulverized sand, and salicylic acid with negative results.



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## ANTISEPTICS

died on the seventh day of peritonitis. The pigs treated with mercurochrome 2 per cent solution, required a longer period to heal, seventeen and eighteen days. Two of the pigs of this group died on the fifth and seventh day of treatment. Where deaths occurred throughout the experiments necropsies and heart blood cultures revealed the cause as either peritonitis or staphylococcus septicaemia. The wounds of all the controls healed in from fifteen to sixteen days. The results of the experiments of series two and three were practically the same as those of the first series. It was observed that mercuriofen was as efficient in 1 per cent as the 2 per cent solution. Also, there was practically no difference in the wounds of those guinea-pigs treated with the weaker solution of mercuriofen (1:500) and with metaphen (1:500) solution. If any, the results were in favor of the mercuriofen. However, compared with 2 per cent mercurochrome and tincture of iodine, both mercuriofen and metaphen (1:500) solutions were superior.

## COMMENT

As previously stated, the object of this study was to determine the antiseptic most suitable for the treatment of local wounds. We were not primarily interested in the strength of the solution, except to apply them in the concentrations recommended.

Our results were uniformly in favor of mercuriofen in 1 and 2 per cent aqueous solution, as it promoted healing within a maximum time of eleven days. The metaphen compound was not as efficient as 1 and 2 per cent solutions of mercuriofen. This was probably because of the difference in concentrations of the compounds, as the most concentrated solution of metaphen obtainable was 1:500.

Although in the first series the iodine was as efficient as metaphen in the animals that live, in the second series the latter gave better results. Tincture of iodine appeared to be too irritating for the tissues and unless used with caution is harmful.

Mercurochrome solution appeared to be the least satisfactory, and in some instances delayed healing, probably because of its physical characteristics.

When the mercurochrome solution dried, a crust was formed which prevented drainage and gave opportunity for the microorganism to multiply. The inefficiency of this compound is perhaps partly because of this property and may have attributed for the death of five guinea-pigs in the three experiments.

Mercuriofen and metaphen did not produce a crust and consequently free drainage was maintained. The thin scab formed in these instances was from the exudate.

Although the local application of some of these antiseptics was of value we believe the mechanical cleansing and free drainage of the wound are more important factors in the healing process than the mere application of antiseptic solutions to already infected wounds.



## SALEFBY AND HARKINS

### SUMMARY AND CONCLUSIONS

Local abscesses were produced in guinea-pigs with staphylococcus aureus. The comparative efficiency of several popular antiseptics was determined, by daily local application, after the removal of crust and pus from the abscesses. The experiment was repeated three times with the same technic.

Our results were uniformly in favor of mercurophen (1 and 2 per cent) solution. The other three in the order of their efficiency were metaphen (1:500 solution), tincture of iodine and mercurochrome (2 per cent) aqueous solution.

Some of the antiseptics used delayed the healing process, as is shown by comparing with the untreated animals.

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# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD NOVEMBER 11, 1931

The President, DR JOHN DOUGLAS, in the Chair

### PENETRATING ULCER OF CÆCUM SIMULATING ACUTE APPENDICITIS-ILEOCECAL RESECTION

DR PERCY KLINGENSTEIN presented a man, thirty-six years of age, who, forty-eight hours before admission, after taking food, had an attack of nausea and vomiting which was repeated. Twenty-four hours before admission he had sharp, cramp-like pains in the region of the umbilicus which later became localized in the right lower quadrant of his abdomen. The pain was persistent and sharp, and associated with a rise in temperature to  $101.5^{\circ}$ . Prior to the present admission, he has had two previous episodes in the last five years similar to the present one. In addition he has had frequent attacks of bronchitis, cough and expectoration, no history of night sweats, afternoon fever or loss in weight.

Physical examination revealed evidences of an old tuberculous process at both lung apices. This was further substantiated by an X-ray examination of the chest which showed diffuse infiltrations in both lungs, anteriorly and posteriorly. Locally, there was abdominal tenderness over McBurney's point, and localized spasticity. A mass could be palpated in the right lower quadrant, but its outline could not be defined. The blood examination showed an absolute leucocytosis. Pre-operative diagnosis—acute appendicitis, possibly with abscess. At operation, under spinal anæsthesia, the peritoneal cavity was entered through a lower right rectus muscle-splitting incision. A moderate amount of free, slightly cloudy fluid was found. The cæcum was covered with a layer of recently deposited fibrin. The appendix was normal in appearance with the exception possibly of congestion. The cæcum upon palpation was tumified and infiltrated to about the size of a hen's egg, the infiltration appearing to occupy the entire thickness of the gut. No foreign body or perforation could be discovered. The terminal ileum was normal in appearance, as was the ascending colon. A resection of the ileocecal junction was performed with a side-to-side ileocolostomy.

The specimen removed consisted of cæcum, appendix, five centimetres of ileum and several centimetres of ascending colon. The ileum showed no gross lesion. The appendix showed a dusky inflammatory color in its distal third. At the base of the appendix near the cæcum there was an extensive ulcerative, necrotizing inflammation over an area three centimetres in diameter. A gangrenous membrane about two centimetres in diameter and minute ulcerated areas covered with a yellowish sloughing base. The wall of the cæcum was much thickened. The serosa was inflamed. The regional lymph-nodes were enlarged. An uneventful recovery followed, the patient was discharged symptom free fourteen days after operation. He has since remained perfectly well.

In 1912, Dr H. H. M. Lyle<sup>1</sup> presented a similar case before this society referring at that time to the monograph of Quenu and Duval, published in

1902 "L'Ulcere Simple dei Gros Intestin" These authors reported thirty-one cases collected from the literature In 1928, Barron<sup>2</sup> collected fifty-three cases Wise<sup>3</sup> recently has brought the literature up to date Of the fifty-eight cases referred to by him forty-five had perforated The location of the ulcers was as follows Cæcum seventeen, ascending colon fourteen, hepatic flexure, five, descending colon two, sigmoid colon, twelve, rectum, four

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DR JOHN E JENNINGS had occasion recently to see a similar case in a woman from whom an acute gangrenous appendix had been removed She made a good recovery but three months later developed a swelling in the abdominal wall This was tender and painful deep under the superficial tissue It was explored and adherent to the anterior abdominal wall a mass of omentum was found in the centre of which was an abscess which communicated through a perforation with the cavity of the cæcum A resection of the cæcum and terminal ileum was accomplished with end-to-side anastomosis The patient made a good recovery and has been well since Doctor Jennings expressed the belief that if more autopsies were performed on fatal cases of gangrenous appendicitis many more of these associated suppurative lesions would be found in that neighborhood than are believed to exist

DR HERBERT WILLA MILLER said that this summer he had operated upon a young girl who had been admitted to the Lenox Hill Hospital with a diagnosis of acute appendicitis The history and physical findings were quite typical of acute appendicitis She had 101.5° temperature, pulse 110, total white cell count of 14,000 and 84 per cent polymorphonuclear leucocytes There was a tender easily palpable mass in the region of the appendix and a diagnosis was made of acute appendicitis with abscess formation Upon operation a perfectly normal appendix was found but through the anterior cecal wall a mass could be felt in the posterior wall of the cæcum The parietal peritoneum close to the cæcum was œdematous and an incision was made and the retroperitoneal space easily entered The tumor mass was found to be entirely in the posterior wall of the cæcum and could be lifted from its bed There was no pus Culture taken was sterile It was decided just to drain the posterior space which was done with a cigarette drain For four days the wound was dry and then pus began to drain and for four weeks thick pus was discharged, after which the wound healed and the tumor mass totally disappeared A barium clysma done some months later showed the cæcum to appear perfectly normal Some eight years ago a similar case was operated upon in which the tumor mass was in the anterior wall of the

## CYLINDROMA OF CHEEK

ascending colon and with similar drainage and similar pus discharge the patient also got well

DR CHARLES E FARR stated that he had operated upon two cases of ulceration of the cæcum, both acute. One was gangrenous. The ulcers were so situated that by removing most of the cæcum with the appendix and performing a plastic on the ascending colon the somewhat more formidable operation for resection of the ileocecal region could be avoided. Both made uneventful recoveries but one had an attack of acute intestinal obstruction within the year. At the second operation a thread-like band was found obstructing a loop of the ileum some distance from the ileocecal valve. This was freed and again convalescence was uninterrupted. It was interesting to note that the cecal region had a practically normal appearance after the resection. This man has remained in good health and it is now over two years since the second operation.

The etiology of this ulcerating and gangrenous lesion of the cæcum is not known. It is possible that diverticula of minute size formed a locus and a portal of entry for infection to get into the bowel wall. There is the possibility also of injury to the mucosa by foreign bodies in the faecal mass. A microscopical study of the lesions has shed no light upon their etiology.

DR JOHN DOUGLAS said that with regard to the cause of this condition it would seem that most of the cases here reported had had appendicitis. The only case in his own experience of ulcer of the cæcum was in a patient whose appendix had been removed. He was a small boy who was again admitted to Bellevue with appendicitis symptoms, and it was thought that there was an abscess of the stump. The boy had a small ulcer in the wall of the cæcum, which was easy to excise and close. There must be more of these cases than are reported in the records.

DOCTOR KLINGENSTEIN, in closing the discussion, said that drainage might have been effective but he had not been sure of the pathology. The patient had bilateral tuberculosis and Doctor Klingenstein had thought he might be dealing with some type of tuberculosis. Where the lesion is located on the anterior wall of the gut and its nature made sure of, local excision would unquestionably be the procedure of choice.

## CYLINDROMA OF CHEEK

DR W HOWARD BARBER presented a case of what appeared to be an aberrant thyroid of the cheek in a boy of fourteen years of age. With a negative family and past history, the boy gave a present history of a growing mass in cheek for the past two years and of two attempts of surgical removal. He was admitted to Doctor Barber's service, Jamaica Hospital, August 19, 1931, for observation, and discharged to follow-up clinic four days later. Physical examination was negative excepting for the local condition. The tumor in left cheek (Figs 1 and 2) was fairly well circumscribed, involved the cellular tissue of cheek anterior to masseter muscle, was about five centimetres in diameter, hard, not tender, and although attached to

operative scar, was movable between skin and mucosa of cheek. The thyroid gland appeared normal and the basal metabolic rate was plus 14.5. The urine



FIG 1—J. S., boy of fourteen years, showing location of cylindroma in left cheek. FIG 2—Lateral view showing site of cylindroma.

was negative. Blood count was 4,180,000 red cells, 80 per cent haemoglobin, 8,000 leucocytes, with 45 neutrophils, 3 eosinophils, 11 large mononuclears, and 41 lymphocytes. Blood sugar was 109.1 milligrams per 100 cubic



FIG 3



FIG 4

FIG 3—Low power microphotograph to show a lobule composed of pseudo alveoli at the periphery and a network of loose epithelial cells in the centre. The hyalin bodies can be seen to bear no special relation to the cells.

FIG 4—Low power microphotograph to show loose arcolar structure with cylindroma hyalin bodies in pseudo alveoli resembling thyroid alveoli.

centimetres, urea nitrogen 12.3, and non-protein nitrogen 23.5, and Wassermann was negative. X-rays of bones of face were negative. The chief interest in this case was centred in the pathology of the tumor. The im-

## CYLINDROMA OF CHEEK

pression of the first operator was that he was dealing with a sebaceous cyst. The description furnished by the pathologists upon first examination was aberrant thyroid. The consensus of opinion at the present time based upon examination by several pathologists, is cylindroma.

The pathological reports follow.

*Laboratory report*—Microscopical section (Figs 3 and 4) shows spaces lined by cuboidal epithelium. These vary in size, some being round, others the size of small ducts and still others dilated. These latter show a content which in staining quality and high refractive appearance resembles colloid. This colloid-like material is present in varying proportions in the section. In the interstices between groups of epithelial acini there are foci of lymphatic infiltration. Other areas show hyalinization and fibrosis. There is no evidence of atypical proliferation to indicate malignancy. The architecture of the section, the appearance of individual cells and the colloid-like content within the alveolar lumina combining with the absence of definite secretory ducts suggests the diagnosis of *aberrant thyroid glandular tissue*.

The pathologists regard the tissue previously diagnosed aberrant thyroid as *cylindroma*, possibly originating in a salivary gland rest. Absence of characteristic colloid stain reaction excludes thyroid derivation. The concentric arrangement of oval cells surrounding hyalinized cylinders makes the second diagnosis a more probable one.

DR CARL EGGERS related an experience he had with a case of cylindroma of the neck in a woman forty-one years of age who had come under his care in 1924. She had a painful tumor in the region of the submaxillary gland which had gradually developed during the preceding year. He believed it to be chronic inflammation due to a calculus. He was able to take out the submaxillary gland with all the fat and lymph-nodes surrounding that region. The pathological report was cylindroma of the submaxillary gland without involvement of the surrounding lymph-nodes. The patient followed a benign course for awhile but about two years later three tumors appeared on the left side of the neck. The outstanding symptom was pain. A radical block dissection of the neck was carried out, removing the three tumor masses together with all fascia, platysma, fat and lymphoid structures. The tumors were identical with the original one. The lymph-nodes were not involved.

During the following year the patient began to complain of double vision. Later her left eye became completely paralyzed, though vision remained fairly normal. There was no external evidence of recurrence but the diagnosis of an intracranial tumor was made. Prolonged X-ray treatment did not bring about a cure.

During the year 1928 several small, painful nodules developed in the scar. They were excised and subsequently there was no recurrence.

The intracranial lesion, however, progressed and the patient finally succumbed five and a half years after the original operation. Permission for an autopsy was not obtained.

The outstanding symptom of this tumor was pain and the chief interest lay in the manner in which recurrences developed. The original growth was within the capsule of the submaxillary gland, and though the latter was removed with surrounding fat and lymph-nodes, metastatic tumors developed at considerable distance from it.

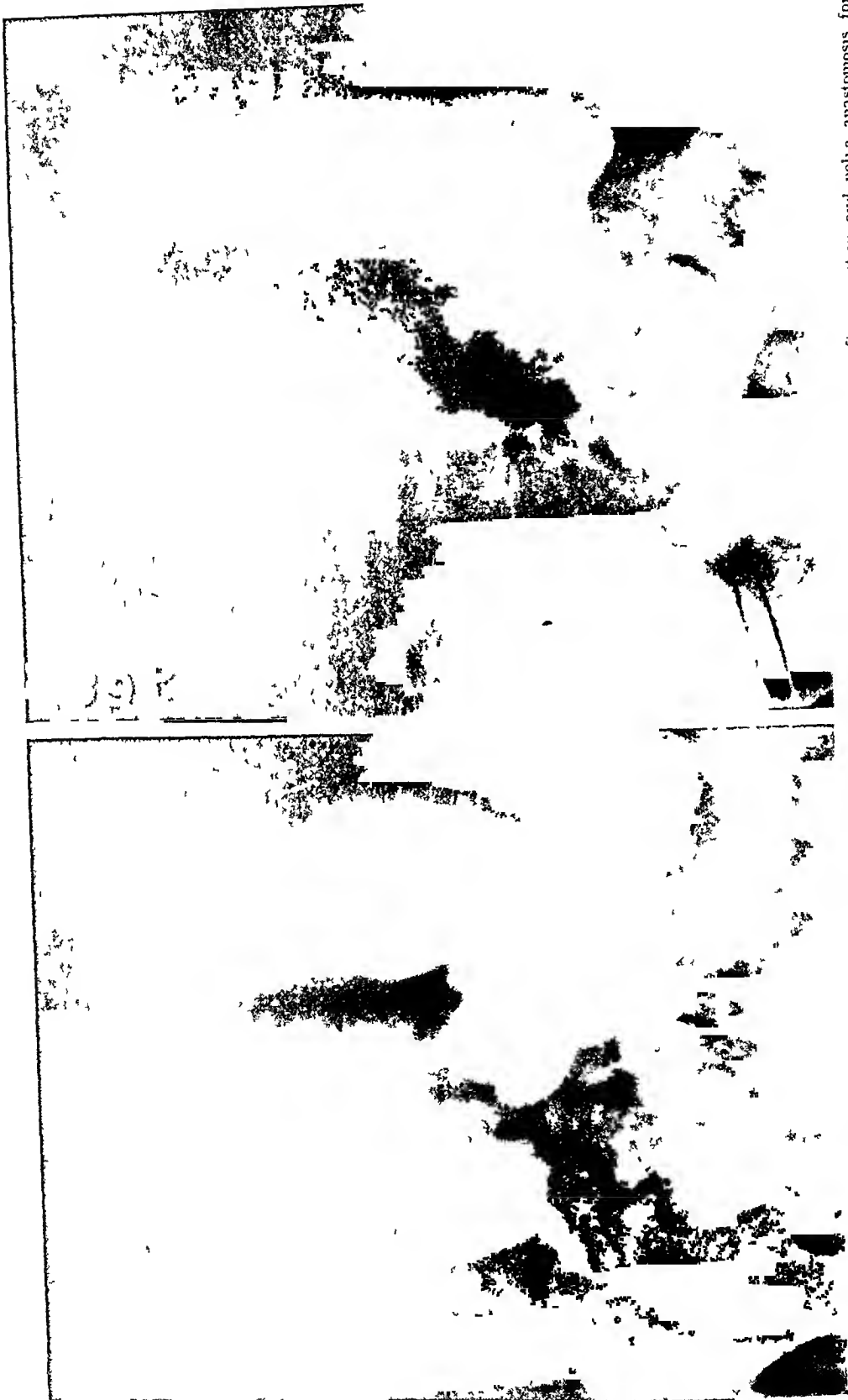


FIG 5 —April 16 1931 Radiograph showing defect in pyloric part corresponding to annular ulcer

FIG 6 —Radiograph showing emptying after resection and pyloric anastomosis for (syphilitic or tuberculous) ulcer of pyloric portion

## TUBERCULOSIS OR SYPHILIS OF STOMACH

DR JOHN M HANFORD said that he recently had seen a child about ten months old who had a lesion in the left cheek the size of this one. It became larger and finally softened and when he saw the child the superficial sinus was ulcerated. It looked like a cyst. Last year one of the junior fellows of the Presbyterian Hospital discovered in a work by George Huntington a small group of cells described as the orbital inclusion. Doctor Hanford thought it possible that Doctor Barber's case and the one he himself had seen were neoplasms which had developed from this group of epithelial cells during the growth of the embryo. The orbital inclusion is thought to migrate from the region of the angle of the mouth toward the ear and orbit.

## TUBERCULOSIS OR SYPHILIS OF STOMACH

DR W HOWARD BARBER reported a case of a colored woman of twenty-three years who entered Bellevue Hospital April 24, 1931, with the history

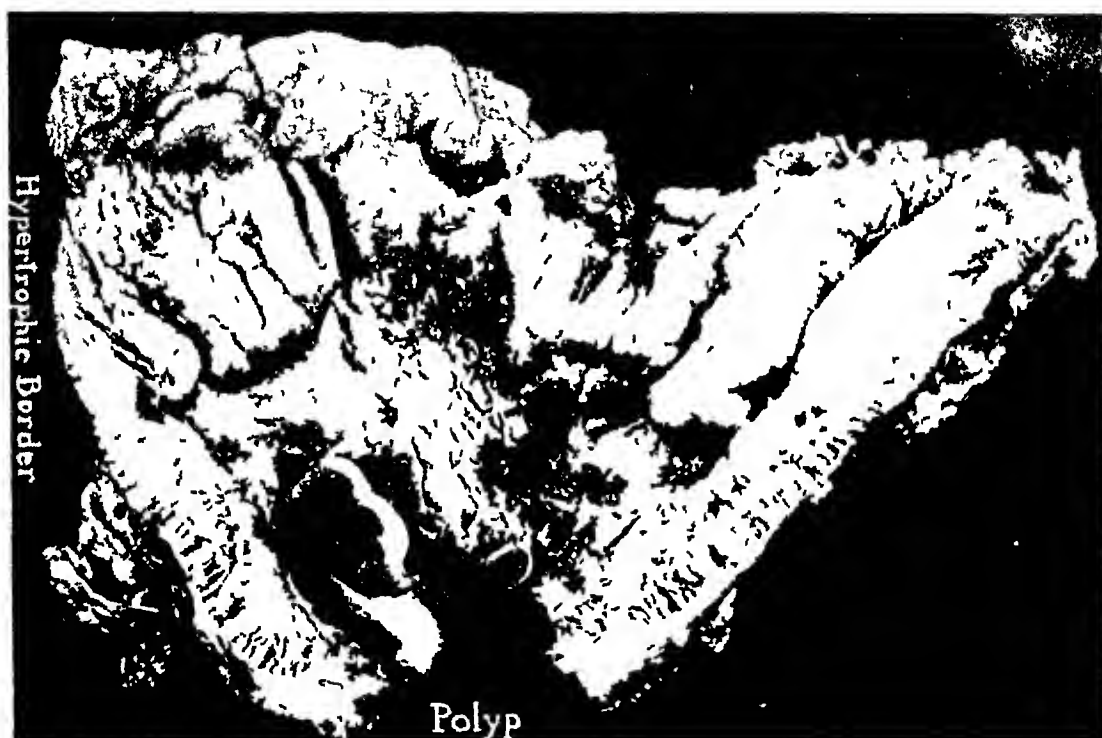


FIG 7 —Excised stomach wall showing annular ulcer and polyp at pyloric sphincter

of pain after meals and vomiting for the past two years. She had lost twenty-seven pounds, so that her present weight was ninety-one pounds. Respiratory and circulatory systems were negative. Vomiting occurred two hours after meals. Six months after the onset of vomiting she began to experience pain after meals. This epigastric pain began as a "fullness" which was relieved by the vomiting or by medication. Both the vomiting and pain were absent during the month preceding admission to hospital, while patient remained on a milk diet. Physical examination at this time was negative excepting for mass and tenderness in the epigastrium.

*The laboratory findings*—Urinalyses negative. Red cells, 4,770,000, hemoglobin, 60 per cent, leucocytes, 4,500–8,200 polymorphonuclears, 67, mononuclears, 2, lymphocytes, 29 and eosinophiles, 2. Blood Wassermann negative, spinal Wassermann negative. Colloidal gold 122710000. Blood-pressure 90/70–120/70. Gastric analyses



negative for blood or lactic acid and free lactic acid remained under 20 cubic centimetres for the first two hours following Boas test meal. Radiographs on April 16, 1931, and June 24, 1931, revealed "the presence of a carcinoma of the pars pylorica. No six-hour retention" (Buckstein) (Figs 5 and 6). April 25, 1931, long bones reported negative for metastases.

May 9, 1931, operation disclosed an extensive ulcer of the pyloric antrum extending from the incisura to the sphincter. The regional glands were enlarged but not particularly hard, the duodenum, liver, and remaining abdomen were negative. A pylorectomy and partial gastrectomy (subtotal) were performed and followed by a posterior termino-lateral gastrojejunal (Polja) anastomosis (Fig 7). Convalescence was disturbed by hæmorrhages on the fourteenth and seventeenth days, otherwise uneventful. She received four transfusions, forced fluids, antiluetic treatment and left the hospital on the first of June. September 18 she reported a gain in weight of thirty-three pounds, was symptom free, and wound in good condition. On October 12 she reported symptom free and gaining in weight.

The most remarkable feature of this case is the pathological report, which follows

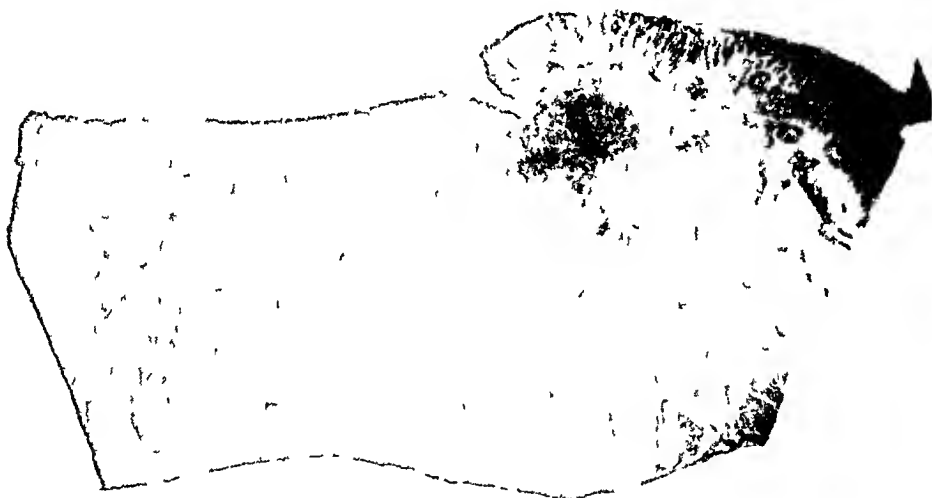


FIG. 8—Low power microphotograph (summar lens 35 millimetres) of edge of ulcer. Note inflammatory base with thickened submucosa of the muscularis and infiltration beneath the mucosa adjacent to the ulcer. (Photograph through the courtesy of Third Division [N. Y. U.] Pathological Service.)

*Clinical diagnosis*—Annular cicatrizing gastric ulcer (gastrectomy).

*Macroscopical examination*—Specimen consists of a portion of a stomach with a small amount of omentum and two lymph-nodes which do not present any evidence of metastasis. Serosa is not injected, pyloric opening admits tip of little finger. On section, wall is thickened, submucosa cedematous, mucosa thickened. There is a spherical fresh ulceration, one and a half inches wide and extending for one and a half inches from the pyloric opening, encircling the entire stomach wall (Fig 8). There is also a polyp-like tumor extending from the pyloric margin into the stomach cavity for a distance of one inch.

*Microscopical examination* shows scattered throughout the wall of the stomach, particularly among the muscle fibres, innumerable large and small circumscribed or diffuse collections of round and plasma cells (Figs 9 and 10). In many instances these collections are arranged in the vicinity of blood-vessels, either circumferentially or eccentrically. In no instance, however, are the blood-vessel walls noticeably thickened,

## TUBERCULOSIS OR SYPHILIS OF STOMACH

nor is there any noteworthy evidence of endothelial proliferation. Among the lymphoid and plasma cells, on occasions, are to be made out solitary giant cells of the Langhans type, without epithelioid reaction in the immediate vicinity. In still other instances the giant cells are associated with the overgrowth of epithelioid cells of the type commonly encountered in tubercles and gummata. In one slide there is a very definite circumscribed formation attended by central coagulation necrosis, arranged radiately to which are ill-formed epithelioid cells, while at the periphery are vast numbers of round cells, many of them of the plasma-cell type, others lymphocytic. The lesion represents undoubtedly either a miliary tubercle or a miliary gumma. It is impossible histologically, with ordinary stains such as hæmatoxylin and eosin, to differentiate between them. Sections are now being stained for spirochaetes to exclude syphilis and for tubercle bacilli to exclude tuberculosis. It is suggested that a provocative Wassermann be done.

In arriving at a histological diagnosis in the present instance, one meets with difficulties which are practically, for the time being at least, insurmountable, for the reasons already described. As far as our experience in this laboratory is concerned, syphilitic ulcers of the stomach are extremely rare, only one indubitable case having

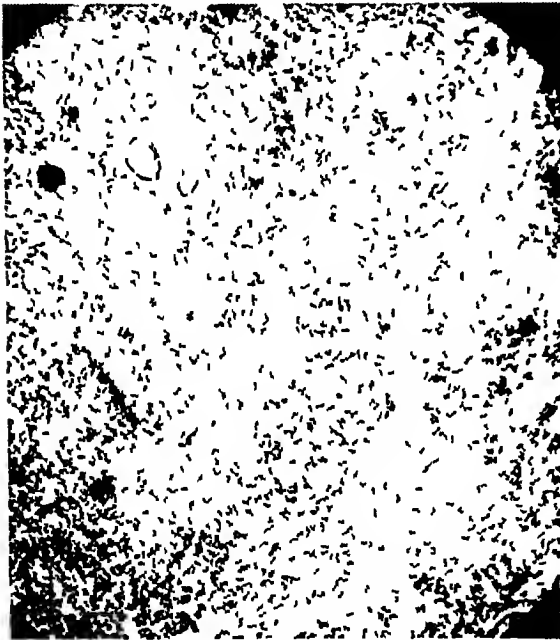


FIG 9



FIG 10

FIG 9—Microphotograph, low power, to show round cell infiltration, giant cell formation, and fibrous connective tissue in the submucosa adjacent to the base of the ulcer. Note the glandular tubules in the depth of the mucosa at the top. (Photograph courtesy Third Division [N. Y. U.] Pathological Service.)

FIG 10—Microphotograph, high power, to show perivascular infiltration by round cells and plasma cells. (Photograph courtesy Third Division [N. Y. U.] Pathological Service.)

been encountered among almost 17,000 autopsies. This experience, however, is not in keeping with that of certain published statements, where syphilitic lesions of the stomach are rather nonchalantly referred to as unusually common. In this laboratory we have once or twice suspected tuberculosis of the stomach, but have never been able actually to demonstrate its tuberculous nature and, as far as I know, genuine tuberculous ulcers of the stomach have never been absolutely proved to exist.

These suggestions of Doctor Symmers were carried out. Neither spirochaeta nor tubercle bacilli were found by special stains. Wassermans and provocatives were all negative. Diagnosis remained either tuberculosis or syphilis of stomach, with the probability in favor of syphilis of the stomach.

DR EDWIN BEER said that in connection with the diagnosis of tuberculosis of the stomach the pathologists will have trouble in establishing this

unless they are able to identify the Koch bacillus in the tissues. A few years ago (*ANNALS OF SURGERY* vol lxxiv, p 245) the speaker showed a case which Doctor Symmers had reported to be tuberculosis without finding the Koch bacillus in which the gross and microscopical specimens seemed identical to the picture Doctor Barber showed this evening. The diagnoses of tuberculosis in Doctor Beer's case, and of lues with a question as to tuberculosis in Doctor Barber's case, were surprising. Both lesser and greater curvatures in Doctor Beer's case were covered with glands and adjacent to the huge ulcer the mucous membrane was undermined just as one sees in tuberculous ulcers of the alimentary tract.

DR RALPH COLP said that in 1927 he presented before this society a case of tuberculous ulcer of the stomach in which at the time of operation an ulcer was found at the recumbent angle of the stomach, and surmounting this a mass of caseating nodes which had to be excised before the gastric artery could be ligated and a subtotal gastrectomy performed.

It was, however, impossible to recover tubercle bacilli from the glands or to find them in the specimen. The pathological picture, however, was typical of tuberculosis. This patient, a Negro, made a good operative recovery, but one month later developed an effusion into the right chest which revealed the presence of tubercle bacilli. Since then the patient has been well and has gained forty pounds in weight. It is thought that some of these tuberculous ulcers of the stomach develop secondary to retrogastric nodes infected by a retrograde lymph flow from the tuberculous glands about the hilus of the lung.

DR CHAS GORDON HEYD thought that this case of Doctor Barber's illustrates the difficulty in the differential diagnosis between tuberculosis and syphilis of the stomach. If one should judge from the reports in the surgical literature, it would seem that gastric syphilis is a common condition. It is however the considered judgment of pathologists that definite syphilis of the stomach is a comparatively rare disease. In a series of 18,000 gastro-intestinal examinations the roentgenologic diagnosis of syphilis of the stomach was made in only five cases. In the combined surgical services of three attendings at the Post-Graduate Hospital in three years, the operatively removed material permitted a diagnosis of syphilis of the stomach in only three cases. In the first case at operation there was enlarged right lobe of the liver presenting many stellate scars and apparently there was no liver substance to the left of the round ligament. In the second case, the pathologist, very much like Doctor Barber's case, could not definitely decide between tuberculosis and lues and the third case was definitely placed as syphilis of the stomach in spite of negative Wassermanns. It seemed to Doctor Heyd, therefore, that lues of the stomach is both infrequent and from a pathological point of view occasionally extremely difficult to diagnose.

## BILIARY FISTULA—TRANSPLANTATION INTO STOMACH

DOCTOR BARBER, in closing the discussion, said that sections had been stained for tubercle bacilli and for spirochæta, but none had been found. In as much as spirochætes of buccal origin might appear in a stomach section their existence in a stained section did not prove a syphilitic lesion. In this case the regional glands were enlarged but not as hard as in carcinoma. Regarding the rarity of syphilis and tuberculosis of the stomach, Doctor Symmers had indicated in his report the incidence of the former to be one in 17,000 autopsies and that of the latter to be more infrequent.

## BILIARY FISTULA—TRANSPLANTATION INTO STOMACH

DR W. HOWARD BARBER presented a woman of forty-six years who was admitted into Bellevue Hospital February 28, 1931, and discharged April 10,

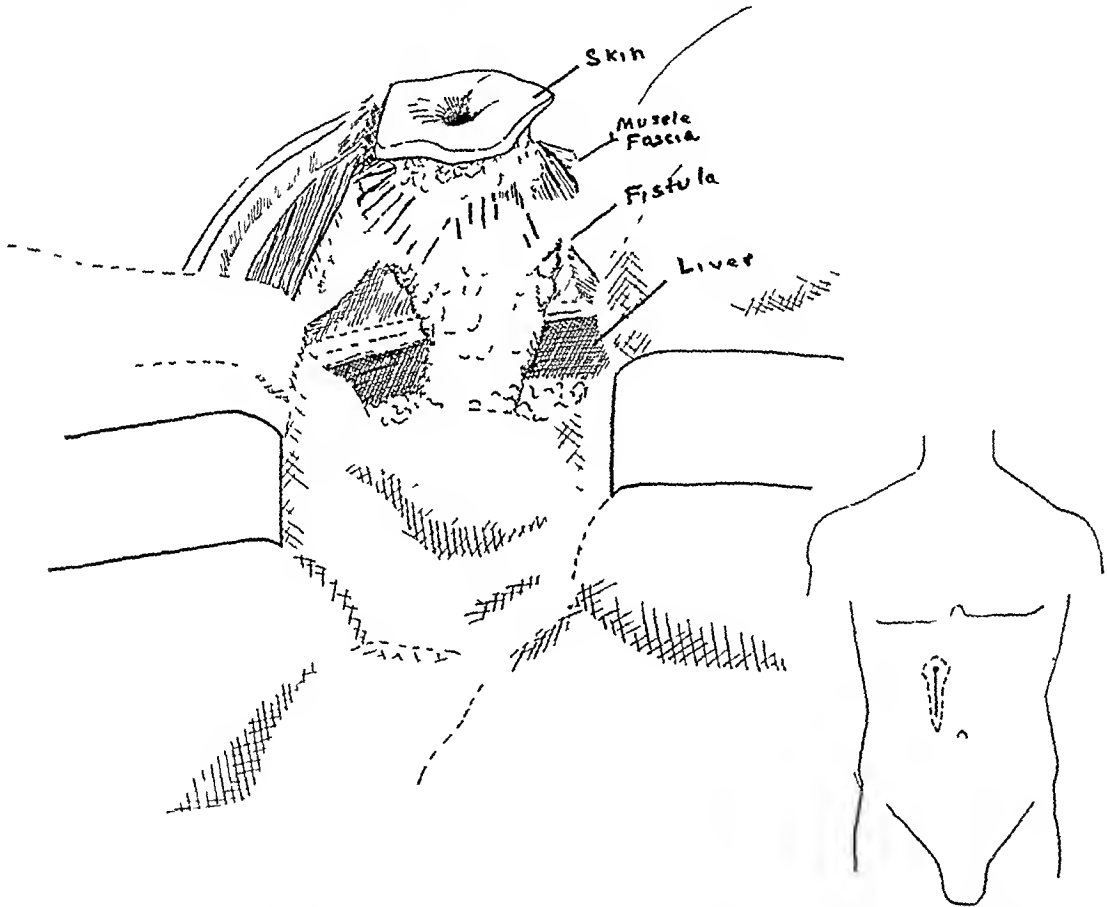


FIG. 11.—Semidiagrammatic drawing to show dissection of a biliary fistula from skin surface to border of liver. Note attached flap of skin, muscle, and fascia purposely left intact to serve as a barrier for suturing fistulous tract to stomach. If the incision in the stomach is kept small the edges of wound snugly fit behind skin flap, and mechanically prevent retracting. Insert shows incision in skin.

1931. She was a multigravida, had had frequent attacks of epigastric pain radiating to right costovertebral angle during the past eighteen years. Eructations, vomiting, and pain without jaundice of any definite degree continued to time of first admission. Physical examination was negative excepting for tenderness in the right hypochondrium. Cholecystography negative. Wassermann negative. Blood sugar, 115 milligrams per 100 cubic centimetres. Non-protein nitrogen, 33. Operation, performed March 16, 1931, revealed a chronically thickened and functionless gall-bladder containing many firmly imbedded stones. Stones were found in the right hepatic duct at hilum of liver. No bile was obtained. There were many adhesions enlarged hilum

nodes, and a thickened pancreas. Liver was normal in size and appearance. Spleen was normal in size and high in abdomen. The gall-bladder was dissected away from liver, incised down to cystic duct, stones were removed from bladder and from duct, but some calculi undoubtedly remained high in hepatic duct, and bladder was excised. Rubber (Mayo) tube sutured to cystic duct and two cigarette drains were left *in situ*. The pathological report by Dr. D. Symmers was chronic cholecystitis with cholestrinization of wall, cholelithiasis. On the third post-operative day bile was observed from the tube, on the seventh day the amount was oz. nss, and jaundice was noted. On twenty-fifth day, patient, still discharging, was referred to out-patient department. Three weeks later, she was re-admitted (May 18, 1931) with complaint of persistent biliary fistula. Lipiodol injected into fistula "reveals a large amount of opaque mixture for a distance of about 3 inches opposite the second and

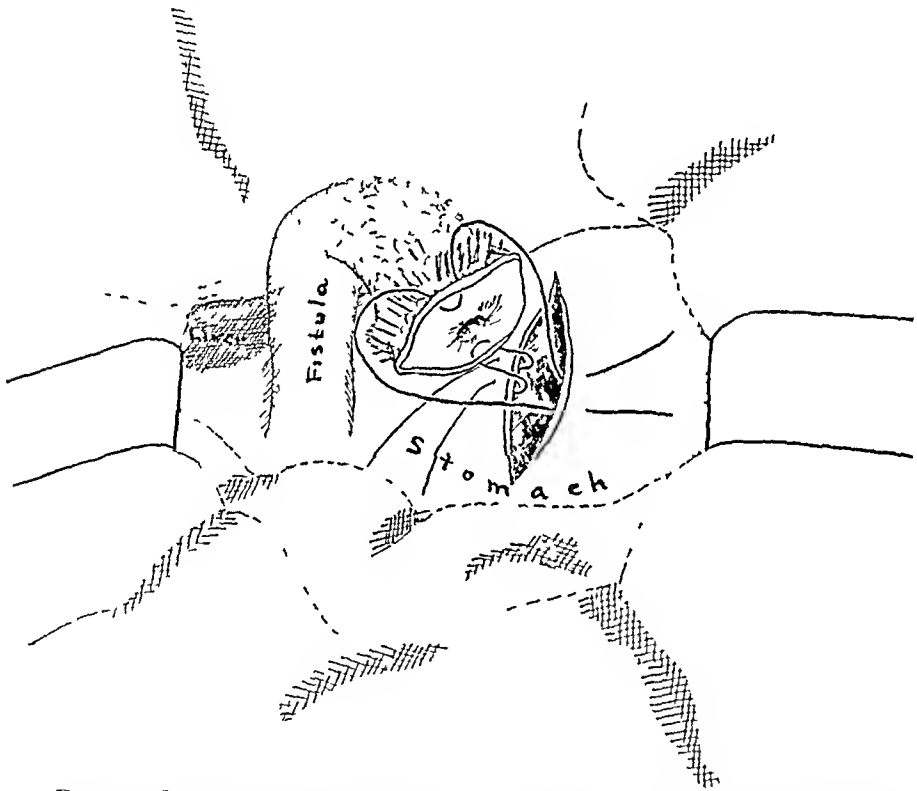


FIG. 12.—Semidiagrammatic drawing to show two mattresses *in situ* in skin flap and in stomach wall—being used as tenacula to draw the fistulous tract into the opening in stomach. The sutures when tied serve an important factor in fixing the stomach and in preventing retraction of the fistula. The "tubs" of muscle and fascia at neck of fistula become useful "holds" for inverting sutures from the gastric wall.

third lumbar vertebræ on right side. The fistula extends apparently in the region of the gall-bladder." June 24, 1931. "No organic lesion of stomach or duodenum. Gall-bladder not visualized."

On May 26, 1931, three months after first operation, operation revealed a well-organized fistulous tract extending from upper end of operative scar to site of former gall-bladder. No stones palpated. No enlarged glands. Liver pale and yellowish. Many adhesions between liver, stomach, and omentum. Fistula was dissected out together, with a plaque of skin four centimetres in diameter to the liver border (Fig. 11). The falciform ligament was divided and pyloric end of stomach mobilized so as to bring the antral region in apposition with mouth of fistula (Fig. 12). The skin flap bearing the external fistulous opening was inserted into antrum through a three-

# BILIARY FISTULA—TRANSPLANTATION INTO STOMACH

Fig 13—Semiagrammatic drawing to show the transplantation of a biliary fistula into the stomach. Purse string sutures 1 ft long to indicate invagination of the stomach.

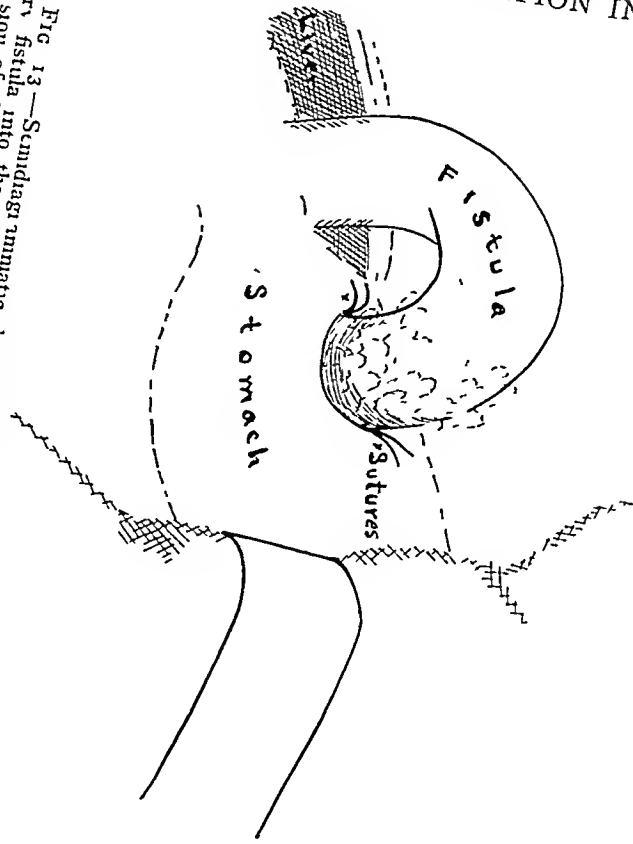
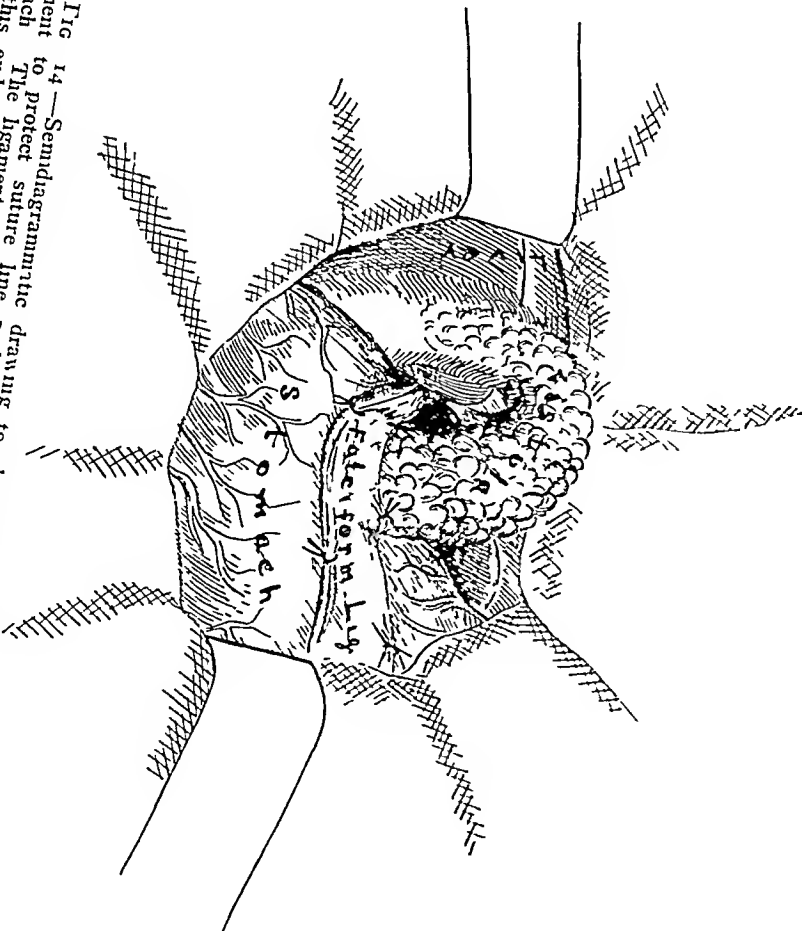


Fig 14—Semiagrammatic drawing to show the utilization of the falciform ligament to protect suture line and to guard against separation of fistula and this end is laid about anastomosis.

The hepatic end is perfectly located to



centimetric vertical incision and stomach was sutured and inverted with interrupted chromic sutures about implantation. Falciform ligament was divided at mural end and was sutured about anastomosis, cigarette drain was left in upper angle of wound below anastomosis (Figs 13 and 14). Wound was closed in layers with chromic gut and silkworm. During the convalescence the patient discharged bile and gastric juice for the first few days. During this interval the maintenance of an intragastric tube, frequent aspiration of gastric contents, abstinence of feeding by stomach, clyses, and transfusions carried the patient over until she was able to take food by stomach. She was discharged June 6, 1931, in good condition, with wound healed. She has been symptom free on a regular house diet and been able to resume her duties as housewife for the past four months.

Of special interest in this case is the utilization of the relatively simple operation of fistula transplantation for a sick patient with inaccessible ducts, no gall-bladder, probable hepatic stones, for a patient who developed pain and temperature if the external bile drainage was temporarily stopped, and of additional interest is the normalcy of gastric function secretory and motor, in the presence of bile.

DR HOWARD LILIENTHAL said that some time ago he had presented a patient on whom he had operated by the same technic as that used by Doctor Barber and a beautiful recovery followed. Doctor Lewisohn assisted him. The patient remained perfectly well and had no jaundice but nine years afterward returned to the hospital with symptoms of pyloric obstruction. Gastroenterostomy was performed and improvement followed. Before she left the hospital an incision was made under local anæsthesia and a specimen removed with a Mixter's cannula punch and it proved to be carcinoma. She died shortly afterward but no post-mortem was permitted. Doctor Lilienthal wished to emphasize the point made by Doctor Barber of leaving the button of skin around the fistula so that when it is in the stomach it will not tend to slip out again. It would, however, have been interesting to find out if this had anything to do with the resulting carcinoma in his case.

DR OTTO PICKHARDT said that Doctor Lilienthal's was the second case in which this technic was employed, Doctor Williams, of Boston, did the first and Lahey the third. Murphy, of Chicago, did one but his case was not successful. It is not a difficult operation but several points should be kept in mind. The core should be large to leave a good broad supply to transplant the sinus, and Lahey recommends that the skin at the other end be taken off. He advises that a small loop be incised into the sinus. The addition of the small opening in the stomach is of great help as one can see how far the sinus is in the stomach. There was no leakage in Doctor Pickhardt's case and the patient has made an uneventful recovery. About 50 per cent of these cases do show a most obstructive form of jaundice which usually disappears on the second or third day.

DR WILLIAM BARCLAY PARSONS, JR., referring to the point about dissecting out the tract, said that about four years ago he operated on a case in

which he made a too free dissection of the tract and the anastomosis broke down. Last July he had another case and adopted the procedure mentioned by Doctor Pickhardt removing the button of skin and using a small tube for anastomosis. The stomach was attached to the under surface of the liver by adhesions, producing an anastomosis of the posterior half of the tract to the stomach, so it was merely a question of uniting the anterior half of the tract to the stomach.

DR THOMAS H. RUSSELL referred to a patient on whom he recently operated in whom the fistulous tract had to be utilized as the common duct. The patient had undergone a cholecystectomy two days before the speaker saw her, at that time she was distinctly jaundiced, the urine contained a moderate amount of bile and the icteric index was 56. Doctor Russell advised exploratory operation as he felt sure there had been an injury to the common bile-duct. That afternoon he opened the abdomen through the incision which had been made two days before and found a ligature had been placed around the common bile-duct at the junction of the cystic duct. When the ligature was released a gangrenous area was noticed on the anterior surface of the duct extending upwards about three-quarters of an inch. The duct was opened and a T-shaped tube introduced. The patient made an uneventful recovery, but at the end of three weeks the tube accidentally slipped out. The wound healed very quickly and she remained well for several weeks, until she came to Doctor Russell again, suffering from severe jaundice, clay-colored stools and a large amount of bile in the urine. April 4 he re-operated upon her and found there was a stricture involving about three-quarters of an inch of the common bile-duct which was completely occluded. The stenosed part of the duct was excised and the two ends of the duct brought together over the T-shaped tube which was allowed to remain in place for six months in order to have a well-organized fistulous tract form around the tube. Care was taken to have this tube come out of the abdomen along the posterior wall and upper surface of the stomach. About six weeks ago Doctor Russell operated on her again and dissected the fistulous tract free down to the stomach, then made an incision parallel to the stomach across the anterior wall and palpated the T-tube through the posterior wall of the stomach. At this point an incision was made through the posterior wall of the stomach into the fistulous tract and the end of the tube that had been exposed on the abdominal wall was pulled through into the stomach. The end of the tube was cut off so as to leave only about one-quarter of an inch protruding into the stomach. The patient made an uneventful recovery and, up to the time she left the hospital which was about three weeks after operation, had not passed the tube. Doctor Russell believed this was a better and safer operation than trying to anastomose the excised fistulous tract into the stomach.

DOCTOR BARBER in closing the discussion said that he regarded the use of the skin flap as very important in the technic of fistula transplantation.



There need be no fear concerning the future of the transplanted tissue exposed within the stomach to the gastric secretion, for experience with cholecystoduodenostomy indicated that such devitalized tissue completely disappeared within a few days (often three days). During this interval the intramural segment becomes vascularized and fixed, making retraction very much less likely. It seemed wise also in dissecting out the tract to leave it somewhat "bulky" to preserve the lumen of the fistula and to facilitate suturing. In this type of case, he thought the stomach would often be found adherent to the right and close to the under surface of liver.

#### MEDIASTINAL TUMOR REMOVAL BY TWO-STAGE OPERATION

DR FRANK S. MATHEWS presented a woman, aged thirty, who came under observation a year ago. She was a strong, healthy-looking woman who said she had had slight hoarseness for seven or eight years. The right vocal cord was found partially paralyzed. There was a mild Horner's syndrome, that is, the right pupil at times contracted, and there was at times slight narrowing of the palpebral fissure. The right lower and upper arm was larger in circumference than the left by about one and one-half centimetres. The veins below the clavicle in the right chest were conspicuously dilated. There was a slight fullness above the clavicle. Nothing else noted in the neck. The X-ray examination of the chest showed a globular mass extending from the apex to the third rib anteriorly and from the mediastinum outward to the right lateral wall. The mediastinum was not displaced and the trachea was almost median. Breathing sounds could be heard both anteriorly and posteriorly to the top of the chest though diminished. There was dullness but not flatness in this same area. The pre-operative diagnosis was a probable dermoid originating in the upper mediastinum and growing outward into the right chest. It was decided to attempt removal in two stages with the hope of not opening, or at any rate, not infecting the right pleura.

The first operation was performed October 27, 1930, under gas ether, with provision for positive pressure. A curved incision was made at the costosternal junction beginning at the third rib, running upward beside the sternum and outward under the clavicle. The pectoralis was split and separated from the second and third ribs. Three and one-half inches of the second rib were removed from the cartilage outward. The pleura was not opened. The inner margin of the lung could be seen moving up and down to just this level. The tumor could be palpated above the lung margin. It felt tense and hard, possibly cystic. Two and one-half inches of the third rib were then removed. The intercostal muscle between the two ribs was divided. Iodoform gauze was packed tightly down on the pleura, pushing the lung margin down as far as the third rib. The wound was closed tightly over the packing.

Following this operation, the patient ran a fairly high temperature for a few days with diminished and later seeming distant breathing. On subsidence of the temperature the physical signs did not suggest a resolving pneumonia. X-ray on the third day showed diffuse clouding of the entire right chest, the heart being drawn a little to the right. The condition was considered an atelectasis, especially as there had been considerable early cyanosis.

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NOTE.—Doctor Barber gratefully acknowledges the helpful cooperation of Dr. Irving Graef, of Doctor Senior's staff, for the preparation of the foregoing microphotographs.

## OBSTRUCTION DUE TO ILEAL IMPACTION

At the time of the second operation, eleven days after the first, the clouding of the right chest had largely disappeared. It had not been the intention to make the interval between operations so long. Under gas the wound was opened and the gauze pack removed. The cut ends of the second rib were identified and the tumor aspirated. Clear, straw-colored fluid was evacuated containing what was considered to be glistening cholesterol crystals. An incision was made through the agglutinated pleural surface in the bed of the second rib and a tumor capsule clearly defined. Digital dissection was then carried out, the dissection proceeding along the outer, upper and lower aspects of the tumor, at first avoiding its mediastinal aspect. The fluid had been entirely evacuated and the blunt dissection proceeded with until the mass was largely delivered and still adhered to the mediastinum between the pulmonary artery and the sternal. Here cutting instruments were used to some extent. The pleura was not opened. Bleeding was very moderate and the lung expanded upward, considerably diminishing the size of the cavity. The amount of oozing seemed to make it unwise to close without any drainage so a rubber dam drain was inserted through a stab wound in the breast and the original incision was closed.

The tumor had a cystic centre, fairly firm fibrous capsule and there was a considerable mass of tissue which on frozen section was reported thyroid. There was no evidence of thyroid tumor in the neck. Wound healing was satisfactory, as was her entire convalescence. She was not nearly so ill following the enucleation as after the costectomy.

It is an interesting question as to whether the operation could have been done at one sitting, but it is to be remembered that the nature of the tumor was quite a surprise. It was believed to be a benign tumor, very likely dermoid or possibly fibroma. She has been well and working for the past ten months.

DR CARL EGGERS said that no single surgeon has had a large group of these cases and it is not possible to make general statements. A mediastinal tumor of the size described by Doctor Mathews is a serious condition and good judgment is required to bring about a cure. The question of time is not very important. The object must be to avoid complications, and this is best done by doing the operation in two or more stages. Each case must be judged individually. To have been able to remove this large tumor in one sitting after a preliminary operation for the purpose of proper exposure and formation of adhesions, without opening the pleura or damaging mediastinal structures, speaks well for the judgment and skill displayed.

## OBSTRUCTION DUE TO ILEAL IMPACTION

DR FRANK S. MATHEWS presented a boy, ten years of age, who came under his care August last. From the age of three he had had attacks of pyelitis with complete recovery between. Four weeks before, in the country, he suffered from pain in the right hip and thigh and walked lame. His temperature once jumped to 104°. A single blood count showed 7,000 cells. X-rays of the hip and thigh on two occasions were negative. The symptoms subsided. Two weeks or more before he had a severe urticaria which affected the skin and larynx, and was relieved by adrenalin. When this developed he had been taking atophan. Thereafter he was on a restricted diet and seemed well, exercising vigorously. Two days ago he ate abundantly of green corn. One day before had pain in the abdomen but no temperature. Cathartic was

administered but vomited. During the last night he vomited at frequent intervals. This morning an enema brought a few fecal particles. Another enema just before he was seen returned clear with strings of mucus. Temperature was  $102\frac{1}{2}^{\circ}$ . Five hours before operation the boy was flushed, tongue moist, not perspiring, restless, turning from side to side, alert when awake but seemed disposed to sleep. Water had been withheld and there had been no vomiting for several hours. The abdomen was definitely distended. There was abdominal pain but not very severe. No peristalsis seen or heard. No definite point of tenderness. No rigidity. Continued pressure on the lower abdomen seemed grateful. There was tympany over the mid-abdomen and very definite shifting dullness. A blood count made shortly before operation showed 15,000 leucocytes, 71 per cent polymorphonuclears. The urine was negative. Just before operation temperature reached  $104.2^{\circ}$ . He was restless, appeared tired, pulse frequent but of good force. He had retained a few sips of water and distention had increased. There was no tenderness in upper abdomen and slight in the lower. Polymorphonuclears increased to 76 per cent. He was thirsty. The history seemed confusing and rather complicated. It rather suggested obstruction. There was absence of appendix history or local tenderness. Distention, free fluid, high fever and moderate leucocytosis suggested an idiopathic peritonitis. Prostration was not marked. Exact diagnosis seemed uncertain but operation seemed urgently indicated.

A right rectus incision was made and an abundance of straw-colored fluid evacuated. Distended but otherwise normal coil of small bowel presented. On exploration a sausage-like mass was felt in the right lower quadrant and pelvis. The first thought was of an intussusception. The terminal ileum and cæcum were readily delivered. The cæcum was empty. The terminal ileum for at least eight inches was distended by a mass of putty-like consistency with some harder particles. This portion of bowel was moderately injected with slight ecchymoses. Just at the ileocecal valve the bowel seemed rather œdematous. By manipulation the contents of the lowermost ileum were expressed into the cæcum after which the remaining putty-like mass was rather easily displaced downward with a resulting ballooning up of the cæcum. Cæcum and ileum were then reduced into the abdomen and wound sutured.

Four days later it was noted that enemas brought hardened feces but today's brought only gas. At times he passes gas and much came with the enema but distention has never entirely disappeared. Temperature has rather promptly subsided. The urine output is good. He takes only fluid seems hungry, but vomits at irregular intervals. On the fifth day a stomach tube was passed and evacuated eight ounces of fluid which did not seem intestinal in character. Clysis of saline and glucose was given. No vomiting during the night. Took water and tea this morning. Two days later, following an enema and pituitin he began to have loose bowel movements. This relieved his distention and vomiting disappeared and he began to retain for the first time fluid nourishment. He remained several more weeks in the hospital, at times with moderate fever with tendency to distention, occasional vomiting usually stating that he was hungry but satisfied with a few mouthfuls of food. An X-ray of the abdomen about ten days after operation with bismuth injected into the rectum showed the colon well outlined in bismuth, and in addition, coils of small intestine much distended with gas.

Doctor Mathews said he had neither seen nor heard of any case in which an obstruction of the small bowel in a child was due to fecal impaction.

## CONGENITAL HYPERTROPHIC PYLORIC STENOSIS IN INFANCY

### CONGENITAL HYPERTROPHIC PYLORIC STENOSIS IN INFANCY

DR EDWARD J DONOVAN read a paper with the above title for which see page 174

DR MORRIS K SMITH said that he thought that the pre-operative care the judgment in selecting time for operation and the post-operative treatment as so successfully carried out on Doctor Donovan's service should be particularly emphasized. Surgeons are learning more and more that careful attention to these matters is essential if the best results are to be attained in surgery. That Doctor Donovan's last 100 cases have included but one fatality is a triumph of judgment and skill in the management of this condition. The fatal case occurred two weeks after operation from gastroenteritis and is not a complication of the operation itself but rather of the infant's rundown condition. In the speaker's personal experience fatalities have been of this type rather than due to the operation itself.

After operation there may be no further vomiting, although many of the infants will throw up occasionally in the first week or more. This was formerly a cause of concern lest the pyloroplasty had not been sufficiently thorough, but as the outcome has been universally favorable there is no cause for worry on this account.

As Doctor Donovan has brought out, spasm is an important factor in pyloric stenosis of infants. Doctor Smith had a patient who on radiography showed not only gastric retention but cardiospasm as well. Following a pyloroplasty the infant made an uninterrupted recovery and had no symptoms referable to the cardiospasm.

DR FRANK S MATHIEWS said that some years ago he reviewed his cases of pyloric obstruction in infants and analyzed them by means of graphs which gave considerable information. The onset was reported sudden in two-thirds of the cases. The age at onset varied from birth to ten weeks, the average age at onset being three weeks. The duration of symptoms at the time of operation ranged from three days to nine weeks. The age of the patients at operation varied from three weeks to twelve weeks, the average age being seven weeks. Thus if the average age at onset was three weeks and the average age at operation seven weeks, it is shown that four weeks are consumed in making a diagnosis, deciding that operation is necessary and persuading the parents to that effect. It would seem that this time might be considerably diminished with advantage to the patient. There were more children who were breast-fed than formula-fed. The chief importance of this observation lay in the fact that the average breast-fed child remained in the hospital thirteen and a half days while the formula-fed infant remained twenty-two days. The late Dr Emmet Holt was a good teacher. Fifteen years ago he told Doctor Mathews to sit down and he would tell him how one makes a diagnosis in these cases. He said there were four means of diagnosis and he would state them in the order of their importance. "First in importance," said he, "is the history. Second the peristaltic waves in

the upper abdomen beginning at the left and passing to the right Third, is the gastric residue determined by passing a catheter into the stomach just before a feeding time, and fourth, there is the palpation of a tumor " The latter he thought not of great importance Some consider the feeling of the tumor as of the greatest importance He thought it probably dependent on the experience of the surgeon in palpating the abdomen not only of these cases but having a background of experience in palpating the abdomen of a considerable number of patients without a tumor

DOCTOR LEWISOHN remarked that a mortality of 1 per cent among 100 consecutive cases of Rammstedt operations was the best proof not only of Doctor Donovan's technical skill but of his good judgment in handling these infants He was glad to see that Doctor Donovan made extensive use of blood transfusions He had always felt that blood transfusion was not used often enough in the pre-operative preparation of bad surgical risks He had performed the Rammstedt operation upon twenty-seven cases of congenital pyloric stenosis between 1917 and 1928 He had no opportunity to perform this operation during the last three years He lost six cases among thirteen patients Among the last fourteen cases he had no operative death, though one baby died about three months after the operation from a gastro-enteritis He was a strong believer in the superiority of breast milk as compared with artificial preparations (thick cereals, *etc*) in the after-treatment of these babies

Doctor Donovan had pointed out that congenital pyloric stenosis occurs very rarely in the female The similarity of the sex distribution in congenital pyloric stenosis and in gastroduodenal ulcers is very evident It is certainly very interesting that the tendency to inflammatory diseases in the pyloric region is not only apparent in the male adult, but in the male baby—an interesting analogy (See Lewisohn *Gastroduodenal Ulcers Jour Am Med Assn*, vol LXXXIX, p 1649, 1927)

DR EDWARD W PETERSON said that infantile pyloric stenosis was described by Armstrong, in 1777, and by Beardsley, in 1778 Hirschsprung wrote on the subject in 1888 In 1898, Cautley could find a record of but twenty cases By 1902, there had been recorded on the literature fifty cases, nineteen of which had been subjected to operation At this time gastroenterostomy was the operation of choice, but the mortality was so high that few physicians cared to recommend surgical treatment In 1910 Fredet suggested an operation, and in 1912, Rammstedt and Fredet published almost simultaneously articles describing a new method of pyloroplasty, which has since revolutionized the treatment of this condition

In the abdominal surgery of infants three conditions in frequency and importance outweigh all other surgical diseases, namely Congenital hypertrophic pyloric stenosis, acute intussusception, and acute appendicitis All three were in former years regarded as emergency conditions calling for immediate operation While the latter two should still be kept in the emergency class, cases of infantile pyloric stenosis should never be operated upon

## PERINEPHRITIC ABSCESS WITH RUPTURE INTO BRONCHUS

until tissue desiccation, chloride depletion and starvation symptoms have been overcome by the administration of glucose and saline solutions, and by blood transfusions in selected instances. Years ago Strauss emphasized the importance of preliminary preparation, and more recently Clopton called attention to the necessity of overcoming the alkalosis which is present in these cases, before any operation is performed. There is no question but that an ounce of proper pre-operative treatment is worth pounds of post-operative effort.

DR CHARLES E. FARR said that his own personal experience of a very modest number of cases was similar to that of Doctor Donovan's, in that his earlier cases gave a high mortality, running over 30 per cent, whereas his later cases all did well.

Doctor Farr has a predilection for local anaesthesia for these operations as it allows plenty of time for the careful technic necessary. The administration of ether to these little babies certainly requires exceptional skill in the anaesthetist and such skill is not always available. He considered about 90 per cent of the problem of congenital pyloric stenosis to be medical in its nature. A very large proportion of these babies can be relieved entirely by medical means. Another large proportion can be tided-over their crises by medical means but with great difficulty and expense. A third but much smaller group seems to be definitely surgical from the onset of symptoms.

DOCTOR DONOVAN, in closing the discussion, said that many of these babies vomited once or twice after operation but that was nothing to be alarmed about. Much as he disliked to disagree with Doctor Mathews, the speaker believed it was essential to the diagnosis to feel a tumor. In his three cases of mistaken diagnosis, there was some real reason why these cases did not receive the usual careful abdominal examination. For example, one case arrived at the hospital with a gastro-intestinal series showing a twenty-two hour gastric retention. The man who asked me to see this case with him thought that he felt the tumor and I thought I did, but I am sure we were influenced by the X-ray findings. Another case had been examined before I saw it by a man who has done a great many of these cases. He was very certain that he felt the tumor and this again probably influenced me. He was sure these three cases were cases of pylorospasm which no doubt give a similar picture except for the tumor. This is why he felt sure that the tumor could always be felt if one took the time to do a painstaking abdominal examination. For the same reason he felt that if one did not make the palpation of the tumor one of the diagnostic signs many cases of pylorospasm which have no tumor at operation would be subjected to operation.

## PERINEPHRITIC ABSCESS WITH RUPTURE INTO BRONCHUS—NEPHRECTOMY

DR PERCY KLINGENSTEIN presented a man, sixty-two years of age, who was admitted, about a year ago, to the service of Dr. A. Hyman at the Beth Israel Hospital, with chief complaints of pyuria for seven months, some dysuria, and attacks of left lumbar pain of three or four weeks' duration.

just prior to admission. His past surgical history consisted of suprapubic cystotomy for vesical calculus followed by prostatectomy at Mount Sinai Hospital six years ago and a posterior gastroenterostomy and pyloroplasty for duodenal ulcer at Beth Israel Hospital two years ago. He was an elderly man thin and poorly nourished, appearing chronically ill. Abdominal palpation showed the presence of a large palpable left kidney with marked left costovertebral tenderness. X-ray examination of the urinary tract showed several large cuneiform calculi in the pelvis of an enlarged left kidney. Examination of the urinary tract with the aid of uroselectan showed a markedly diminished function on the left side with a normally outlined pelvis and calices on the right. Cystoscopy showed frank pus coming from the left

kidney with a normal secretion and normal function from the right. Blood chemistry was within normal limits. Hæmoglobin, on admission, was 57 per cent. 3,500,000 red blood-cells. Urine examination showed a specific gravity ranging from 1014 to 1020 with many red blood-cells and white blood-cells in the sediment. After a preliminary transfusion, and under spinal anaesthesia the left kidney was exposed through a loin incision. The kidney was found to be enlarged to about three times its normal size and completely surrounded by a massive perinephritis, to which the colon was intimately adherent. In attempting to mobilize the kidney, a large collection of foul-smelling pus was entered.

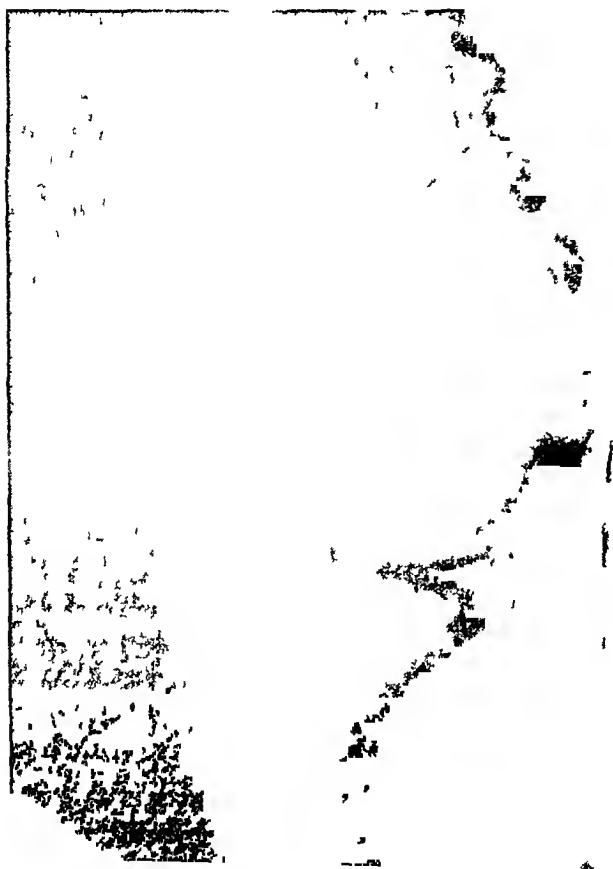


FIG. 1.—Skiagraph showing sinus tract outlined with lipiodol.

In view of the patient's poor condition, it was deemed advisable to drain the perinephritic abscess rather than attempt what would undoubtedly have been a very difficult nephrectomy. The abscess cavity was drained with two rubber tubes and the wound loosely sutured. Following this procedure the patient ran a low, irregular temperature, which was persistent. Thirty-two days following the first operation, during a routine irrigation of the wound with acriflavin, patient experienced a paroxysm of coughing and it was noticed that he coughed up large quantities of yellow-stained watery fluid. It was evident that the patient had a communication between the perinephritic abscess and the bronchial tree. In an attempt to establish this, the sinus was outlined with lipiodol (Fig. 1). The patient's general condition, in spite of the absence of retention, was becoming poorer. It was thought that the infection in the kidney was the source of the chronic sepsis, and it was de-

## REMOVAL OF INTERNAL MENISCUS OF KNEE

terminated to perform a nephrectomy. This was done under nitrous oxide and oxygen anaesthesia after removal of the twelfth rib. The kidney capsule was incised, shelling an enlarged kidney out of its capsule, first anteriorly where pus was encountered and then posteriorly. Both poles of the kidney were then mobilized and after separating the upper pole a definite blow was heard coming from underneath the region of the diaphragm. The pedicle was identified and ligated. Following removal of the kidney, the wound was left open and a large Mikulicz tampon was inserted. The specimen consisted of a ruptured kidney, the pelvis filled with soft greenish concretions. The surface was studded with small cysts. The pelvis and calices were distended and filled with seropurulent material.

Following the second operation, the patient's temperature gradually subsided, the wound became clean and granulated slowly. The fistula closed spontaneously. The general condition of the patient continued poor. There was marked emaciation and a profound secondary anaemia, not influenced by blood transfusion, and for which no cause could be found. Examination of the gastro-intestinal tract showed the presence of an old duodenal ulcer but failed to reveal evidence of carcinoma. At this time his weight dropped to eighty-six pounds. Two weeks after the temperature became normal, he began to gain weight, gaining fourteen pounds in two weeks. Patient discharged thirteen weeks after admission. At present his wound is healed, he has gained considerably in weight, and feels perfectly well.

Extension of perinephritic suppuration into adjacent viscera with the production of internal fistula has been recorded much more frequently than rupture of such a collection into a bronchus. The latter would tend to occur more often on the left side where the liver does not act as a defending barrier.

## REMOVAL OF INTERNAL MENISCUS OF KNEE

DR PERCY KLINGENSTEIN presented a woman, twenty-two years of age when first seen by him three years ago. At that time she complained of pain and disability in her left knee-joint. Her first symptoms dated back five years prior to that time as the result of an injury sustained in a game of basketball, when she was thrown to the ground with the knee in a position of flexion and internal rotation. There was also a history of typical locking on the outer side of the joint, where there was tenderness. She was then operated upon, and the left external meniscus removed through a left lateral incision. She was symptom free until she consulted the reporter. While she was relieved for a time, she then noticed that she had a recrudescence of her former symptoms but the symptomatology seemed to have shifted from the external to the internal aspect of the knee-joint. Her knee, while walking up the stairs or attempting any form of exercise would give way, throwing her to the ground, and would become locked in partial flexion. Following this the knee would become painful and swollen. In addition she experienced pain over the internal aspect of the knee in the region of the anterior attachment of the internal meniscus. She also noticed in this location a small body which with displacement, permitted complete extension. That knee was slightly larger than the corresponding right. The muscles above the knee-joint were slightly atrophic. There was good motion both in flexion and extension, no lateral mobility. There was a definite point of tenderness over the anterior attachment of the internal meniscus, but no loose body could be palpated. There was a well-healed scar on the lateral aspect of the joint. X-ray examination was negative. An exploratory arthrotomy was advised.

Under general anaesthesia a long parapatellar incision was made on the



inner side of the joint, displacing the patella outwardly. The synovial membrane of the joint appeared thickened and congested. The alar ligaments were slightly hypertrophied. The internal meniscus was found detached at its anterior extremity in a bifid manner. On the under surface of the internal femoral condyle there was a small erosion of the cartilage which was covered by granulation tissue and around which the cartilage was vascularized. The anterior portion of the internal meniscus was removed and the joint closed in layers with fine chromic gut. The knee was encased in a tight circular bandage. The patient's post-operative course was uneventful. Active motion was instituted one week after operation. An effusion into the knee-joint subsided without the aid of aspiration. She walked with the aid of a cane ten days after operation. She was discharged well two weeks after operation. Since that time the patient has had complete return of function. The symptoms have completely disappeared, she uses her knee freely, partakes of normal exercise and has had no return of her former trouble.

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STATED MEETING HELD NOVEMBER 25, 1931

The President, DR JOHN DOUGLAS, in the Chair

#### CARCINOMA OF CÆCUM PARTIAL ENTEROCOLECTOMY

DR CHAS L JANSSEN presented a woman, fifty-two years old, who was admitted to the Presbyterian Hospital February 17, 1930. She had had vague abdominal pain for one year and recently clamp-like and more severe abdominal pains. There had been no nausea or vomiting. Three weeks prior to admission, she noticed blood in her stools. The bowels moved regularly but the consistency of the stools was unusually soft. There had been a marked and rapid loss of weight, loss of strength, dyspnoea and palpitation on exertion.

When admitted her temperature was  $101.0^{\circ}$ , pulse 110, respiration 22, blood-pressure 115/80. In the right lower quadrant there was a hard, movable mass. The liver was not palpable. There was no distention or visible peristalsis. The blood count was 3,890,000 red blood cells with 60 per cent hæmoglobin, 10,750 white blood cells with 74 per cent polymorphonuclears. Urine showed glucose but the blood sugar was 86. Blood urea was 23. X-ray of the colon showed a persistent obstruction in the right colon. The diagnosis was carcinoma of the right colon.

*Operation*—After a week of preparation the patient was operated on under spinal anaesthesia. The abdomen was entered through a right transverse incision. There was a hard mass about 10 centimetres in diameter in the cæcum. The appendix was drawn into the tumor and showed signs suggestive of a subacute inflammatory process. However, the appearance of the mass was quite characteristic of a neoplasm. Several nodes were made out along the ileocolic vessels. The liver was apparently free of metastases. An ileocæcal resection was performed. The distal end was closed immediately by an over-and-over suture reinforced by a second row of seromuscular Lembert's suture. This was further protected by an omental pad. About 15 centimetres from the ileocæcal junction, the ileum was then cut transversely with the cautery between two Kocher's clamps. When the tumor and its main lymphatic drainage area had been removed, the posterior peritoneum was repaired.

## CARCINOMA OF CÆCUM PARTIAL ENTEROCOLECTOMY

The anastomosis between the ileum and transverse colon was made by the closed or so-called aseptic method. To accomplish this, a cone of the anterior wall of the transverse colon was grasped with Allis' clamps and a Kocher's clamp applied at the base of the cone. The protruding tissues were excised by cautery. The clamp on the closed end of the ileum was brought alongside the clamp closing the opening in the transverse colon. Two posterior rows of seromuscular suture were taken and after bringing the clamps in close contact, one anterior row taken so that the clamps were entirely buried except at one point. After removing the clamps, the small remaining opening was closed. The second row was then completed. Patency of the anastomosis was obtained by digital palpation. A Witzel's ileostomy was performed and the tube brought out through a separate stab-wound incision through the left rectus. After anchoring the region of the anastomosis and colonic closure to the anterior peritoneal wall, the wound was closed with lateral drainage by a cigarette drain. The patient stood the procedure well and was transfused afterwards.

Pathological examination of the specimen showed a large, fungating, cauliflower tumor of the cæcum. The appendix was invaginated in the tumor at its base and showed signs of acute inflammation.

The microscopic section showed a well-differentiated adeno-carcinoma of the cæcum with some invasion of the muscular wall but no extension beyond the subserous tissue. Mitotic figures were fairly frequent. The lymph-nodes did not show evidence of metastases.

The convalescence was uneventful. The ileostomy tube was left in place for two weeks and the wound through which it came out closed promptly after its removal. There was a trivial infection in one point of the coeliotomy wound. The patient was discharged in good condition one month after the operation. X-rays taken since discharge showed an anastomosis functioning well.

This patient was presented to call attention to what is thought to be a very satisfactory technic of anastomosis on the colon. Although similar technics have been described and used by several surgeons for the last fifteen years, the impression is that it has not yet obtained the recognition it deserves.

DR ALLEN O WHIPPLE said that the method used by Doctor Janssen is one that has been used at the Presbyterian Hospital for a number of years. The speaker had first seen it used by Doctor Blake sixteen or seventeen years ago, it impressed him as being feasible. The results have been so excellent that a number of surgeons have used it since. Four weeks ago Doctor Whipple used it in a similar case and the convalescence was smooth and uncomplicated. In connection with anastomosis of the large intestine, if a method of this sort can be used it has some advantages. In regard to the clamps, the Kocher blades have to be very slender so they will not take up too much room when turned over, and the same principle applies to the handles, so they will not interfere when they are rotated. The aseptic method has advantages and disadvantages but in the upper part of the colon where the presence of a diaphragm makes little difference this technic has distinct advantages.

DR HUGH AUCHINCLOSS said that whenever the question of this form of anastomosis comes up there is criticism because of possible obstruction. He

first saw this method done in 1914, and has used it in several cases since that time. It can be used in end-to-end as well as end-to-side anastomosis. He had just seen a patient in whom there had been a carcinoma of the large intestine just below the sigmoid, in the upper rectum. This type of anastomosis was done on her in 1918. The sigmoid and upper rectum were resected. A small perforation had caused two loops of small intestine to become adherent to it. Clamps were placed on the sigmoid and upper rectum and an end-to-end anastomosis done in the non-contaminating fashion described by Doctor Janssen. One hundred and fifty-two months after operation the patient weighed 132 pounds and seems perfectly well. In another case of advanced carcinoma of the descending colon an abscess had formed in the left iliac fossa. At operation, twenty months ago, resection of the carcinoma at the junction of the sigmoid and descending colon was performed with the clamp method—no mucosal suture being done. A film taken a few days ago showed a smooth sigmoid.

One should not deny the possibility of diaphragm formation, for that it may occur has been amply demonstrated. The amount of necrosis and the duration of sloughing, not to mention individual susceptibility to the formation of scar tissue and degree of peritoneal investment, are factors. Of course, where the feces are fluid, as in ileocolostomies, obstruction is less likely. Cases of long standing with satisfactory function by means of this noncontaminating method are capable of being demonstrated.

DR EDWIN BEER said that in connection with the formation of a diaphragm at the point of anastomosis, whether due to the oedema of the stoma or to the non-sutured free end of the intestine, he believes that this can be fairly well controlled by using interrupted stitches. The use of a continuous running stitch was more liable to pursestring the bowel and in that way predisposes to obstruction or diminution of the stoma. As far as the question of aseptic anastomosis is concerned, there is no doubt that all such procedures are infinitely superior to the old-fashioned way of anastomosing, as they lead to much less contamination of the operative field. On the other hand, it is very evident that even at best the operation is not absolutely aseptic, as, even with the electric cauter, in cutting through between clamps one has to traverse the contaminated intestinal lumen. This may be avoided by using a very broad crushing clamp two to three times the width of the Payr clamps.

DOCTOR JANSSEN, in closing the discussion, said that although continuous sutures were used the stitches should be taken very close together. Excessive traction on the sutures should be avoided so as not to cause a pursestring action. As regarded asepsis, it was only by tradition that this procedure was called aseptic, but in comparison with other methods it is a very great improvement. The main thing is that there is no perforating stitch. With regard to marked diaphragm, with great care it is possible to avoid this.

FAMILIAL POLYPOSIS OF COLON WITH CARCINOMA OF RECTUM  
FAMILIAL POLYPOSIS OF COLON WITH CARCINOMA OF RECTUM  
AND SIGMOID ABDOMINO-PERINEAL PROCTO-SIGMOIDECTOMY

DR CHARLES L JANSSEN presented two patients, brothers, both of whom had multiple polyposis of the colon

The first case was a twenty-eight-year-old man who when seen for the first time in July, 1930, was complaining of hemorrhoids of seven years' duration. He had been told, however, seven years ago that he had polyps of the rectum. The symptoms being mild at that time, he did not pay much attention to this diagnosis. Since three years, after a period of increasing constipation, he developed attacks of mild diarrhoea and occasionally noticed



FIG. 1.—Male, aged twenty-eight. No. 8 of pedigree. Polyposis of rectum and colon. Carcinoma of rectosigmoid with metastases.

red blood in his stools. Two months before admission he observed mucus in the stools. Otherwise there were no gastro-intestinal symptoms. There had been no loss of weight. Proctoscopic examination showed a large number of polyps of varying sizes, shapes and nature of attachment. The proctoscopic tube could not be passed beyond the recto-sigmoid junction where a large cluster of polyps was seen. A specimen of one of the polyps showed adenomatous changes but no malignancy. X-ray examination of the colon revealed round areas of diminished density which were thought to be consistent with colonic polyposis. It failed to show any definite sign of malignancy.

*Operation*—Under spinal anaesthesia a coelotomy revealed numerous

masses in the rectum and sigmoid. One of them was large and hard and had a very large satellite adenopathy. The liver was free of metastases.

An abdomino-perineal procto-sigmoidectomy was done with a permanent colostomy.

The specimen, which was 40 centimetres after fixation, showed innumerable polyps of various sizes in the rectum and sigmoid with an adenocarcinoma of the sigmoid. The lymph-nodes in the vicinity of the growth showed metastases. There was also a good-sized vein with a mass of tumor cells in the lumen. The section of the carcinoma showed infrequent mitotic figures and a great deal of mucous production. Several polyps examined showed only benign glandular hyperplasia.

The patient was discharged forty-one days after operation. He was in good condition and his perineal wound was healing rapidly. He has enjoyed good health

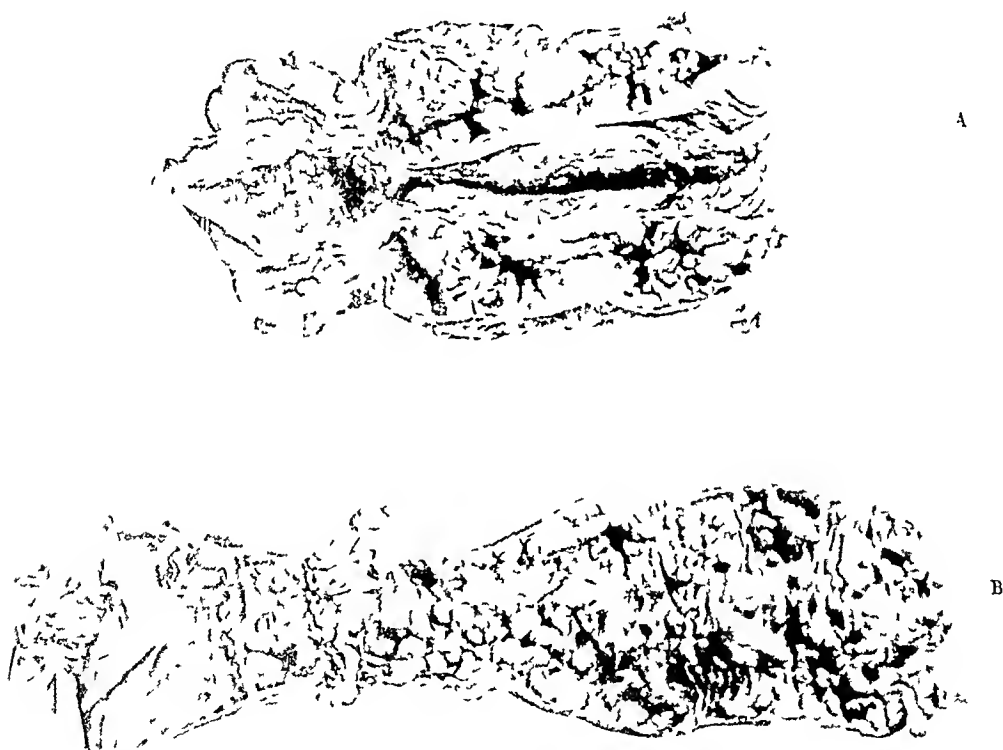


FIG. 2.—Male, aged forty five. No. 5 of pedigree. Polyposis of rectum and colon. Multiple carcinomata with metastases. A—Distal part of specimen. B—Proximal part of specimen.

since the operation. His colostomy that had been functioning well until six weeks ago gave him at that time some trouble. The opening had become obviously too small to allow free bowel action. Therefore, a plastic was done which proved successful. The patient has gained 24 pounds since the operation and is back at his normal weight. The remaining colon still contains several polyps. Several were removed through the colostomy opening. The advisability of another partial colectomy is worth considering.

A second case was then presented who was the brother of the previous patient. This man, forty-three years old, complained of diarrhoea for one year. There was no mucus nor blood in the stools. He had had occasional griping pains in the rectum. There was a loss of about 7 pounds in weight in the last six months.

# FAMILIAL POLYPOSIS OF COLON WITH CARCINOMA OF RECTUM

Proctoscopic examination showed numerous polyps of the rectum. About 3 centimetres from the anus there was a mass very suggestive of a carcinoma and at 10 centimetres there was a characteristic malignant tumor encircling the lumen of the rectum. Here also biopsy did not show any positive malignant changes. X-ray of the colon showed almost complete obstruction at the recto-sigmoidal junction with an irregularity in the outline. When another barium enema was given after the introduction of a catheter above the stricture area, the colon was outlined and showed multiple areas of lighter density suggestive of polyps.

At operation on January 23, 1931, the recto-sigmoid by palpation showed numerous masses movable in the lumen, presumably polyps, and also at least two areas where the consistency of the rectal walls was very suggestive of

## POLYPOSIS AND CARCINOMA

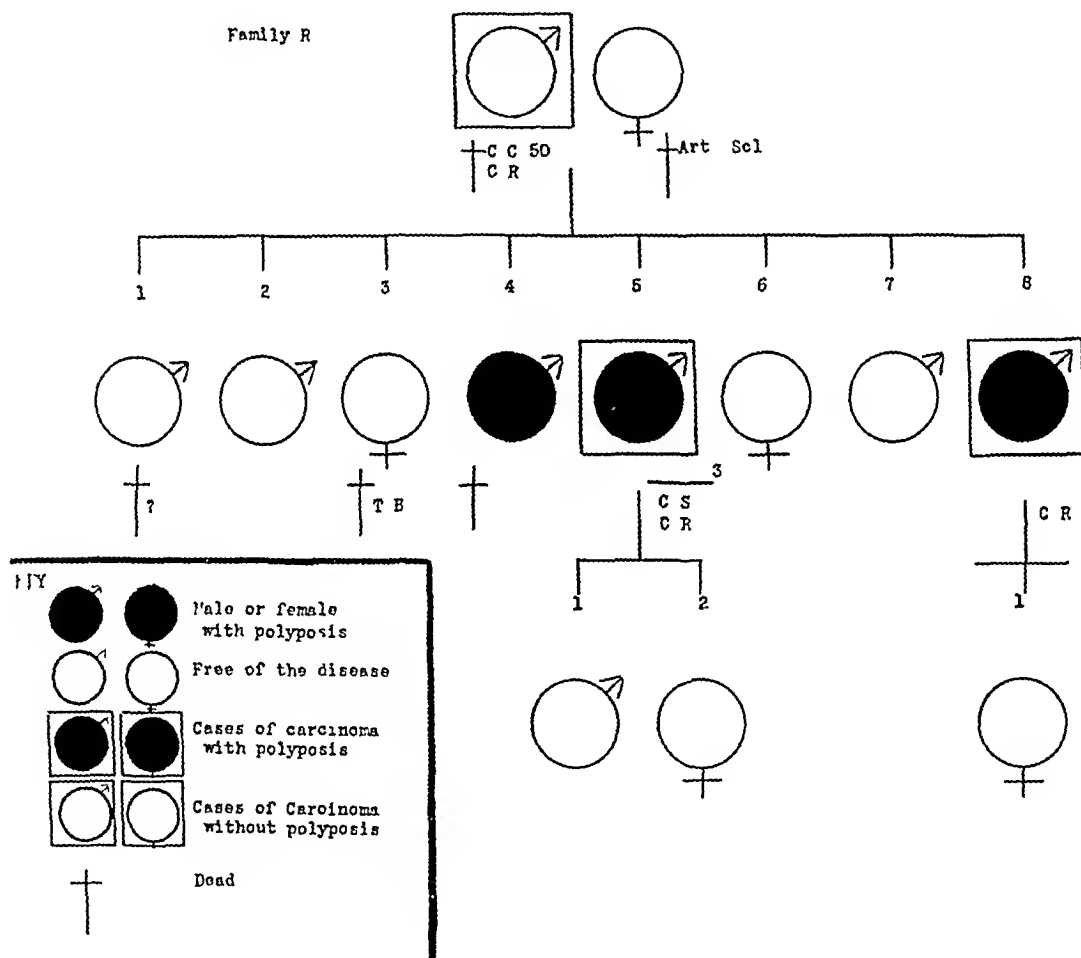


FIG 3—Individuals of third generation not recorded were said to be symptom free but were not examined by the writer. Symbols as in Dukes' paper, *The Cancer Review*, vol 1, No 4, 1930

carcinoma. There were numerous hard nodes in the pelvic mesocolon. The aortic nodes were not palpable. The liver was apparently free of metastases. An abdomino-perineal procto-sigmoidectomy was done with a terminal left colostomy. The specimen showed innumerable polyps—four carcinomatous—in the rectum and sigmoid. The nodes showed extensive metastases. Some of them had evidence of calcification and one of ossification. This probably antedated the development of the carcinomata. The tumors showed mitoses in extraordinarily great numbers. One of the adenomas was of the villous type.

This patient also had a rapid and smooth convalescence. He was dis-

charged on the twenty-ninth day with the abdominal wound healed, the colostomy in good condition and the perineal wound healing nicely. He has been in good health since the operation. He has gained 14 pounds. He still has polyps in the remaining parts of the colon.

These two cases of polyposis of the colon with carcinoma, in brothers, unusual as they were, are especially interesting in the light of the family history. The father died at the age of fifty. It was learned that a colostomy had been performed on him by Dr. Arpad Gerster in January, 1906. The diagnosis was carcinoma of the rectum and splenic flexure. Although the evidence of underlying polyposis was not obtained, the fact that he had two carcinomata of the large gut makes this hypothesis very likely. The mother died of arteriosclerosis. There were eight children. The eldest one died of an unknown cause. The second, a man, has been examined and found free of any disease. A sister died at twenty-four years of tuberculosis (pulmonary). The fourth, a boy, died at 22 years. He had been operated on in August 1925, by Dr. John Linder, of Brooklyn. The diagnosis was multiple papillomata of the colon. The fifth child is the second of the brothers presented. The sixth and seventh children are alive, were examined and found free of polyposis. The eighth is the first patient presented. The children of these two patients were proctoscoped and no evidence of disease found. Since presentation of these two cases another member of the family has been examined and found to have polyposis of the colon. He is twenty-three years old, a son of patient No. 4 of the second generation who also was suffering with polyposis.

Although rare, these cases of familial polyposis have been reported occasionally.

#### BLEEDING DUODENAL ULCER. PARTIAL DUODENO-PYLORECTOMY. POSTERIOR GASTROJEJUNOSTOMY, APPENDICOSTOMY, ENTEROENTEROSTOMY.

DOCTOR JANSSEN presented a twenty-year-old girl who was admitted to the Medical wards of the Presbyterian Hospital October 20, 1930. Nine days previous to admission, she suddenly felt very dizzy and weak. After resting for about ten minutes, however, she recovered enough to continue about her work. The next day she developed a diarrhoea and noticed that her stools were tarry. The following days, although she was able to work, she continued to feel weak and had several fainting spells. On one occasion, she vomited but she did not remember if the vomitus contained coffee-ground-like material. She became so weak that she could not stand erect. For a period of one year she had had occasional dull non-radiating epigastric pain occurring two to three hours after meals.

On the day of admission she vomited twice and the vomitus was also guaiac positive. Her Wasseimann was negative. The urine examination was negative. She received an immediate transfusion of 600 cubic centimetres of unmodified blood. During the next days she was given nothing by mouth. Then on the fourth day, she was started on the Sippy diet. But on account of the persistence of symptoms, her fluid intake was stopped completely again and she was given fluid by the parenteral route. In spite of this, she failed to show any improvement. Two transfusions were ineffective. She showed progressive weakness, her temperature rose progressively to 103.4° and her pulse rate to 130. The stools were still guaiac positive.

By the twelfth day of conservative treatment the picture was very alarming. She still had tarry stools, ran a high temperature, had a pulse rate of 130, her blood count was 1,520,000 with hæmoglobin 35 per cent and her blood-pressure was 95/25. The opinion was that there was an ulcer of the posterior wall of the duodenum with bleeding from a rather large branch of the pancreaticoduodenal artery.

*Operation*—Avertin, gas and oxygen anaesthesia. A transfusion was given at the onset of the surgical procedure and one at the end of the procedure. The abdominal cavity was entered through a right upper rectus incision. The small and large intestines were loaded with tarry material. As the accumulation of blood in the intestine was held to be responsible for the pyrexia, an appendicostomy was performed through a right lower quadrant stab wound. The pyloric region and the duodenum were explored by doing an axial duodeno-pylorotomy. The ulcer was located in the posterior wall of the descending portion of the duodenum. The crater was about 2 centimetres in diameter and the floor of the ulcer made of the head of the pancreas. A small blood clot was seen at one point on the bottom of the ulcer but no brisk oozing was observed. It was then decided to do a duodeno-pylorotomy. After ligating the vascular pedicles, the duodenum was cut transversely in front of the ulcer but it was soon found that the rather low location of the lesion would not allow an easy closure of the duodenal stump as the posterior duodenal wall had been destroyed by the ulcer and dissection below the lower level of the lesion was deemed unsafe. Therefore, a rather unusual type of closure was performed by separating the serosa and muscularis from the mucosa of the anterior wall. The mucosa was sutured to the head of the pancreas by interrupted chromic suture and a second row of suture obtained by suturing the serosa and muscularis on top of this. Then a piece of omentum was fastened on top by interrupted chromic gut stitches. A pylorotomy was then done and a short loop Pólya operation made to reestablish the continuity of the gastro-intestinal tract. The patient stood this procedure well. It was believed that the one transfusion made this possible. During the following days, she was given large amounts of fluids by the intravenous route and also through the appendicostomy. She had a constant gastric drainage for four days. It was discontinued when it yielded decreasing amounts of gastric content. The temperature and pulse rate came down to normal on the sixth day. The colonic flushing through the appendicostomy was discontinued on the eighth day because the returns were clear.

The patient was apparently doing very well when she started vomiting on the eleventh day after operation. In spite of a reduced intake after operation, the emesis increased to 900 cubic centimetres a day, the temperature rose slightly and the pulse rate went up to 120. She was X-rayed and it was found that the greater curvature of the stomach reached the brim of the pelvis in the erect posture and that no barium passed through the stomach.

It was then decided to reoperate. *Operation*—The afferent loop was found slightly distended and the efferent loop collapsed. Under spinal anaesthesia, an enteroenterostomy was done between the afferent and efferent loops. Following this procedure, convalescence proceeded satisfactorily except for an intramural abscess at the sight of the appendicostomy. This was drained. Finally, as the appendicostomy was still open an appendicectomy was performed. The blood count rose progressively to normal without the need of any transfusion.

The patient has been followed at regular intervals and was put on an ulcer



regime She had been completely symptom-free and her weight, which was 82 pounds at the onset of convalescence, went up to 138 pounds

The speaker presented this case because he believed it to be an unusual example of failure of conservative treatment that made an operative procedure imperative As simple gastrienterostomy in similar cases usually gives unsatisfactory results, this more radical procedure was performed Appendicostomy is suggested as a useful adjunct to the treatment It is felt that the duodenal closure used will find its indication in occasional cases The enterointerostomy if done at the initial operation might have avoided the post-operative high ileus

DR CHAS GORDON HEYD said that the interesting portion in the treatment of this case was the enterointerostomy He recently had operated on a man for bleeding ulcer and after doing a simple uncomplicated gastroenterostomy, the patient was remarkably well for five days, and then began to vomit large quantities of greenish-black material, as much as 3,000 cubic centimetres in twenty-four hours After forty-eight hours of this condition he was reoperated and an enterointerostomy performed The second operation did not benefit the patient as the vomiting continued and three days after the second operation a jejunostomy was performed In a communication to the Philadelphia Academy of Surgery in May, 1931, Dr Frederick A Bothe reported three very interesting cases representing the same mechanism as in Doctor Janssen's case and in Doctor Heyd's case In Doctor Janssen's case his enterointerostomy functioned perfectly but in Doctor Heyd's case it was unavailing The interesting condition in Doctor Heyd's patient was an acute inflammatory reaction of the exit or distal loop of the gastroenterostomy, whereby the entering or proximal loop of the gastroenterostomy emptied all of the duodenal material into the stomach, but no egress was possible It seemed to Doctor Heyd that this must be, while not an infrequent condition, still not a rare one, and that some of the cases in which it was theoretically assumed that a spur was present probably had this mechanism as a basis for disturbance

DR RICHARD LEWISOHN thought it was impossible to make a general statement in regard to the treatment of acute bleeding ulcers Every case required individual treatment He believed that most surgeons wait too long for operative interference Prolonged medical treatment of bleeding ulcers has a considerable mortality It is generally conceded that operation at the time of a profuse hæmorrhage is a dangerous procedure An effort should be made to tide the patient over the acute stage If bleeding persists, however, surgery is strictly indicated

DR HUGH AUCHINLOSS said that some years ago he had operated on two cases of this kind within a year and both died On the Medical Side they had bled white and been sustained only by transfusions In both cases he did a gastroenterostomy In the first case he tried to exclude the pylorus by a heavy, silk, subperitoneal purse-string ligature This case continued to bleed In the second case he believed he should have done a pylorotomy

## THE CURE OF LARGE VARICOSE ULCERS

In spite of the precarious condition of the patient he thinks it probably would have been successful. At all events, it would have been logical.

Duodenal ulcers can be classified in many ways. Ulcers associated with penetration of the coats may well be considered as, first, those threatening diffuse peritonitis, and, second, those threatening hæmorrhage. Those threatening diffuse peritonitis are on the anterior wall. Those that perforate the posterior wall are the ones that bleed. Operations for posterior-wall perforations are more difficult than those on the anterior wall. Pylorectomy is the best way to stop the bleeding. It is something of an operation, however, and naturally one hesitates to do it. Nevertheless, one possesses, in transfusions, a better weapon than is available for many other types of complications, and more pylorectomies should probably be done when ulcers bleed than are done. When they are bad enough to have to be operated on, they are not likely to stop when only a palliative type of operation is done, and the base of the ulcer is usually formed by an open pancreatico-duodenalis vessel, artery or vein.

DR EDWIN BLEER said that the problem of operating for an acute hæmorrhage from the alimentary tract is complicated by the fact that in many cases one has no idea whether the bleeding comes from an ulcer or not. If pre-operatively one is relatively sure from X-ray studies and history that the patient has an ulcer, repeated massive hæmorrhage surely demands operative control if possible, as there is no doubt that the patients who are not operated upon may bleed to death. In view of the fact that the operation is by no means free from mortality, it is evident that an exploratory for massive hæmorrhage without a positive diagnosis may be more threatening to the patient's life than medical, conservative treatment. Many cases of massive hæmorrhage from the alimentary tract have been seen without any evidence in the history that the patient was bleeding from an ulcer. The patients have usually recovered, and have never had any gastro-intestinal symptoms. In this group of cases, without a definite diagnosis, an exploratory operation would probably be more often a risk to the patient than a benefit.

DOCTOR JANSSEN, in closing the discussion, said that the rationale of the appendicostomy was that in such a case it might have been difficult to get promptly a normal bowel movement so the opening was made to relieve the colon of the large amount of blood that had accumulated. Six litres of saline were used every day through the appendicostomy while a small tube was introduced into the rectum. When the return was clear the appendicostomy tube was removed. The temperature came down on the sixth day although the patient had previously been running a temperature as high as 103.4°.

## THE CURE OF LARGE VARICOSE ULCERS BY EXCISION AND SKIN GRAFT

DR GRANT P. PENNOYER presented two women to illustrate an operation for the cure of very large varicose ulcers of long standing at the Peter Bent Brigham Hospital in Boston.

The operation consists of excising the entire area of the ulcer and the underlying scar tissue and deep fascia followed by immediate skin graft. The deep fascia and subcutaneous tissue in the cases will be found to be quite avascular and very much thickened. It is excised completely, leaving a thin layer of areolar tissue over the underlying muscle, or if it is over the tibia, leaving a thin layer of periosteum on the tibia. When this plane of cleavage under the deep fascia is found it can be followed by blunt dissection. The only bleeding of any consequence is usually from one or two thick-walled varicose veins running into the ulcer region. The excision should be done out to relatively normal tissue, one-quarter to one-half inch from the edge of the ulcer. When this excision is complete there is a large excavation in the leg with the muscles or periosteum in the bottom of the wound. This is covered with Thiersch grafts taken from the thigh. The various grafts are placed so as to overlap each other and not leave any tissue uncovered by graft. Perforated rubber tissue is then placed over the grafts on top of this a dressing, and then a rubber sponge which is held firmly in place with adhesive straps which are not disturbed for six days. This sponge is an important part in the technic as it furnishes just the right amount of pressure on the grafts to hold them firmly in place and it also absorbs the wound discharge.

The secret of the success of this operation, according to Doctor Homans, is the establishment of a new blood and lymph supply from the deeper tissues to the grafted skin area. The excision of the thickened deep fascia permits a fresh source of nutrition from the deeper circulation.

These two cases were selected on account of the very long duration and the extraordinary size of the ulcers. Neither patient has diabetes or syphilis. The first patient had an enormous ulceration which was of thirteen years' duration. It involved over half the circumference of the lower leg and was six inches in length. She was operated upon February 25 of this year. It can be seen that the area is well healed and has a nice normal soft skin. She has subsequently developed another small ulceration but the grafted area has normal nutrition and blood supply.

The second patient had also a very large ulceration of eight years' duration. She was operated upon April 5, 1929, by Dr. Howard Patterson and has remained well ever since.

DR. FENWICK BEEKMAN expressed particular interest in these cases because it had been his experience that in these old ulcers in which granulations have gone on to cicatricial tissue the only cure is to excise this tissue and use skin grafts. He had presented a case of a woman who had an ulcer over the malleolus which healed when she remained in bed but recurred when she was up and about again. He had excised the ulcer, moved in a triangular flap from the dorsum of the foot, and skin grafted the area from which he had removed the flap. There was no recurrence following this procedure. These are important types of cases but because they are so common, little attention has been paid to them and they have been left in the hands of the juniors on the hospital staffs.

DR. HENRY W. CARR said that he had had the opportunity of watching two or three of these cases of Doctor Pennoyer's on the wards of Roosevelt Hospital and it was impressive to see the skin heal so nicely over the

## TRAUMATIC AMPUTATIONS OF THE THIGH WITH COMPLICATIONS

part that has been excised. So many of them recur with only bandaging and rest in bed that he considered this a feasible aid and the correct procedure in certain extensive chronic ulcer cases.

### TRAUMATIC AMPUTATION OF THE THIGH COMPLICATED BY BOTH TETANUS AND GAS GANGRENE

DOCTOR PENNOYER presented a woman, twenty-three years of age who was admitted to Roosevelt Hospital, February 16, 1929, immediately after an automobile accident. She had sustained a compound comminuted fracture of the left femur at the junction of the middle and lower thirds of the shaft with such extensive destruction of the soft parts and avulsion of the skin that there was little, if any, circulation below the site of injury. The muscles and fat were ground in dirt which came from the bridle path in Central Park.

The patient was in severe shock. The first treatment was directed toward this condition. She reacted well, and in two hours the systolic blood-pressure had risen from almost nothing to 110. She had already been given the usual prophylactic dose of 1,500 units of tetanus antitoxin. She was taken to the operating rooms, and under ether anaesthesia the wound was carefully cleansed and débrided of all dirt and devitalized tissue. The skin and subcutaneous tissue had been torn loose well up toward the groin anteriorly, and posteriorly from the mid thigh down below the popliteal space. The structures in the popliteal space were exposed as if they had been dissected out. The popliteal artery was intact but it did not pulsate. It was evidently thrombosed by the trauma. The femur fragments were held in exact position by a steel plate. Numerous Cairrel-Dakin tubes were placed so as to irrigate the wound thoroughly, and the skin was only partially drawn over the denuded areas. A posterior splint was used for immobilization.

The general condition improved during the next twenty-four hours, but gangrene started in the toes. During the next twenty-four hours this gangrene spread with astonishing rapidity up to the knee. The whole lower leg was dark brown and was infiltrated with gas bubbles. Gas appeared in the wound, and the skin flaps took on a bronze hue. Smears of the copious wound discharge showed *Bacillus welchii*, with numerous other pyogenic organisms. The patient's temperature rose to 105° F., and the pulse rate to 140. Under nitrous-oxide anaesthesia a guillotine amputation was done at the mid thigh, leaving the wound wide open. The original wound was full of gas and gangrenous muscle tissue. The amputation was done just high enough to avoid most of this. Numerous Dakin tubes were placed in the open cleavage planes between the muscles and underneath the skin flaps.

The patient improved after this operation and there was never any extension of the gangrene except in the skin flaps, though typical *Bacillus welchii* organisms were found in the wound discharge more than two months later.

February 23, the seventh day after admission and four days after the amputation, the amputation stump began to twitch occasionally in clonic fashion like a localized convulsion. These seizures lasted from five to thirty minutes and were extremely painful and distressing to the patient. Tetanus was considered but as a prophylactic dose of antitoxin had been given it was considered improbable and a dose of only 3,000 more units of antitoxin was given at this time. During the next two days these local convulsive seizures of the muscles became much worse. They would stop for a short time, and then the slightest movement or noise would start the process again. The

patient developed a severe headache, but there were no other meningeal symptoms

On the tenth day after admission, Doctor Winslow reported tetanus bacilli in pus taken from the wound, establishing the diagnosis of tetanus. At once an injection of 20,000 units of antitoxin was given intravenously and 15,000 intraspinally. Some improvement in the symptoms was apparent the next day, and a dose of 20,000 units more was given intravenously. The following day, the twelfth, a dose of 20,000 units was given intramuscularly, making a total of 79,500 units given up to this point, which was thought would be sufficient. Four days later, improvement ceased, and there was a definite remission. An injection of 20,000 more units was given intramuscularly. This seemed sufficient for six days, when the colonic contractions of the stump muscles, which had about disappeared, returned. An injection of 15,000 units was made near the site of the anterior femoral nerve. This region was selected because the anterior muscles supplied by this nerve seemed to be the only ones involved in the convulsive seizures, and the pockets of pus from which the bacilli were still recovered lay anterior to the femur and in the adductor canal. Immediate relief of symptoms followed this injection, and subsequent experience seems definitely to prove that the antitoxin acted much more quickly when injected in the region of the nerve along which absorption of the toxin was taking place.

One week later the seizures again returned, and an injection of 6,000 units was made. Meanwhile the wound was cleaning up very satisfactorily, though tetanus and gas bacilli were constantly found in the deeper pockets. This recurrence of symptoms about a week after the last dose of antitoxin, continued till April 18, about two months after the onset of active tetanus symptoms. A total dosage of 130,000 units of antitoxin was administered in this interval. Tetanus bacilli and *Bacilli welchii* were found in the wound up to April 10, about two months after injury.

The patient never had any evidence of a serum reaction or serum sickness. Apparently there was a constant production of tetanus toxin in this patient and as soon as the injected antitoxin was neutralized or excreted, symptoms returned.

A minor plastic operation and traction by weights on the skin helped considerably to heal the large granulating area. An osteomyelitis of the lower end of the femur complicated the situation. She left the hospital in good condition, May 18, three months and two days after admission. A sinus remained until a sequestrum was extruded and the wound was entirely healed by July. She is now in good health and is walking well on an artificial limb.

This case is reported to illustrate the following facts:

- (1) A combination of extensive gas gangrene and tetanus, even in a very large wound, is not necessarily fatal.
- (2) The prophylactic dose of 1,500 units of tetanus antitoxin followed in seven days by 3,000 units does not always prevent tetanus.
- (3) Tetanus bacilli under certain conditions can produce recurrent symptoms after the disease has apparently been arrested by antitoxin.

DR ALFRED STILLMAN remarked that regarding the symptom of twitching of muscles in the wound site, he had seen a similar case while in service in France in a patient with bad thigh wounds in which the debridement left both sciatic nerves exposed. He believed at this time the twitchings were due to the exposure of the nerves to irritation of dressings, *etc.*, and did

## BILATERAL NEPHROLITHIASIS

not recognize tetanus. The patient died that night of tetanus four days after injury and in spite of a prophylactic injection of antitetanic serum. This was vividly recalled and so Doctor Pennoyer was urged to use serum as quickly as possible and in large dosage and then to take a smear.

The method of injecting the serum is of interest. The intravenous route is the best, the intramuscular and subcutaneous are not so good as absorption is so slow. Doctor Pennoyer gave it intraspinally but Doctor Stillman doubted the value of that. Only the toxin at the site of formation and in the blood can be neutralized by the antitoxin.

One must remember in doing secondary operative procedures, even if the patient has no continuous signs of tetanus, to give antitetanic serum again as the old disease may be lighted up.

DR HENRY H. M. LYLE said just such cases as Doctor Pennoyer describes were not infrequent in the late war. To guard against recurrent attacks of tetanus the French issued orders that all the wounded requiring reoperation or manipulative treatment that might stir up a latent tetanus were to be given protective doses of antitoxin serum and the doses were to be repeated for each procedure.

## BILATERAL NEPHROLITHIASIS

DOCTOR PENNOYER presented a man, fifty-three years of age, who was admitted to Roosevelt Hospital, Second Surgical Division, August 8, 1928, complaining of pain in both kidney and bladder regions, milky urine, fever and prostration.

The symptoms had started three months previously but had become much worse the last three weeks.

The essential findings on examination was an enlarged tender left kidney, urine full of pus, blood count 13,120, 74 per cent polymorphonuclears, temperature 103°, pulse 110, and obviously a very sick man. X-rays of the kidney regions showed very large calculi on both sides. First dye test only 10 per cent excretion in two hours. The blood chemistry on admission showed a blood urea nitrogen, 46.0, uric acid, 7.0, sugar, 105, creatinin, 2.0. Cystoscopic examination showed that only pus was coming from the left side and very cloudy urine from the right. He continued to run a very septic fever and a generally downhill course. His blood urea nitrogen rose in ten days to 61.90, his creatinin to 3.5, uric acid to 8.0. The temperature rose to 105° at times. It was decided that in view of his downward course and of the presence of the large pyonephrosis of the left side, with no secretion of urine from this side that this kidney might be the chief factor in his sepsis and that it was justifiable to attempt a nephrectomy. The left kidney was accordingly removed under spinal anesthesia on August 27, 1928, eighteen days after admission to the hospital. The kidney was a large, multilocular bag of pus containing nine calculi up to five centimetres in diameter. During removal the sac was broken and a large amount of very foul-smelling pus escaped. Large rubber drains were inserted. He made a remarkable recovery, temperature dropped to reach normal in six days and his general condition immediately improved. On discharge October 17, six weeks after operation, his blood chemistry was normal and dye output 53 per cent in two hours. He has been seen frequently at recall clinic since. He has gained eighty pounds in weight and is doing his regular work with no complaints.

His blood chemistry taken last week was normal and his urine shows a faint trace of albumin and a small amount of pus.

The case was shown to illustrate the difficulty of estimating the function of one kidney in the presence of sepsis resulting from the other kidney, and also to show the great recuperative power of the kidney when the sepsis is relieved. Incidentally, it presents an example of a man with a very large renal calculus at the present time with no resulting symptoms. In his judgment it would be unwise to attempt to remove this calculus in spite of the low-grade infection which we know it is causing.

DR EDWIN BEER advised caution in doing a nephrectomy in one step in pyonephroses associated with blood urea retention and inadequate function of the second kidney. Routine one-step nephrectomy in these cases for a long time has been recognized as a dangerous procedure, with a much higher mortality than a two-step procedure, primary drainage followed by nephrectomy when kidney function on the second side has become normal, or almost normal. As far as operating upon the second kidney and removing the stones, Doctor Beer advised such a procedure to control the infection.

#### ANGIOMA OF THE THUMB

DR JOHN DOUGLAS presented a man, sixty years of age, who had noticed a bluish swelling on the ulnar aspect of his right thumb seven or eight years previously. This gradually increased in size and was diagnosed as an angioma. It caused him very little trouble until shortly over a year ago, when it increased in size more rapidly and extended further up the dorsum of his hand. At this time he had an operation which consisted of removal of part of the angiomatous tissue and an enlarged artery and vein extending up on the back of his hand to the level of the wrist-joint. The patient states that at this time the vein pulsated. Following the operation there was a further increase in size of the angioma and the patient noticed an increasing blueness on the palmar aspect of the end of the thumb. An attempt was made to reduce the size of the angiomatous areas by injection treatment, using small amounts of glucose and quinine hydrochloride and urethane. This did diminish the swelling in the area in which it was used but in the past two or three weeks the angiomatous area on the radial side of the thumb had greatly increased in size and about four weeks ago an area about one centimetre in diameter broke down, forming an exceedingly painful ulcer which it has been impossible to get to heal.

Doctor Douglas presented this case for advice as to what should be the further treatment. The patient is a dentist by occupation. The lesion, which is on his right thumb, is becoming worse and the X-ray of the bones in the thumb seems to indicate that the angiomatous process has invaded the first phalanx. So far, treatment has been unavailing and the possibility of ultimate amputation must be considered.

DR CHAS GORDON HEYD said that he recently had a case almost identical with this one. The patient had an angioma of the right thumb occupying about two-thirds of the terminal phalanx and equally distributed on the dorsal and palmar surfaces. On compressing the thumb the blood could be squeezed out almost like water out of a sponge, and upon releasing the pressure the blood would immediately fill out the angiomatous tissue. By means of a

## ANGIOMA OF THE THUMB

Cameron coagulation needle a series of linear cauterizations was carried out extending from the tip of the thumb well up and under and beyond the base of the nail. The same procedure was carried out on the palmar surface. The result was complete obliteration, in the course of about six weeks, of the entire angiomatous tissue. In regard to the X-ray pictures of Doctor Douglas' case Doctor Heyd stated that it was not unusual in conditions of hyper-vascularization to have changes, either in the form of increased periosteal proliferation or even to the point of some bone atrophy.

DR RUSSEL H. PATTERSON said that he first saw this patient some six months ago, at which time examination showed the right thumb to be larger than normal. There was a scar on the radial side of the thumb about the middle of the first metacarpal bone. An attempt had been made about a year ago by another surgeon to remove several of the larger vessels on that side of the thumb. The distal phalanx of the thumb consisted of bluish discolored skin underneath which lay masses of dilated blood-vessels which could be compressed until the skin came in contact with the bone. X-rays showed the bone to be very porous. It seemed the blood-vessels had absorbed great channels through his bony substance.

A very competent dermatologist was consulted. He advised against the use of radium, X-ray treatment, or any kind of electrical treatment.

During the last few years Doctor Patterson has injected quinine and urethane hydrochloride into hemangiomas with uniform good results. Therefore it was thought that such treatment might be carried out on this case. Accordingly at intervals such injections were given on the ulnar side about the base of the thumb. A thickening and obliteration of certain veins at this point did take place. Due to the very poor condition of the skin on the distal phalanx it was not thought advisable to inject this area. The patient has continued at his work, as a dentist, he has continued playing golf and on several occasions has received fairly deep contusions of the thumb. As a result of one of these contusions necrosis of a small area occurred on the end of the thumb, moderate low-grade inflammation ensued. The thumb has not had careful regular daily surgical dressings.

It is believed that absolute rest and careful dressings would still cure the thumb, and it is highly unlikely that the patient will cooperate 100 per cent. In such treatment the coagulation of the vessels in the end of the thumb would certainly be advisable providing the skin would not be broken down by such treatment.

DR HENRY H. M. LYLE said the first thing to do was to get the pathological diagnosis of the section removed for examination. Regarding the healing of the ulcer, rest, protection and support of the local circulation were necessary. The latter would be improved by wearing of a suitable perforated rubber glove the perforations to take care of the discharge from the ulcer. In looking at the X-ray film Doctor Lyle believed that the bone findings are not similar to those of a varicose ulcer because there is no direct



evidence of inflammatory changes in the bone, there is no periosteitis, nor does he believe that it is an osteoporosis from pressure because there are no signs of osteoporosis, but there are signs of similar circulatory condition in the bone itself

If this is a congenital arteriovenous aneurism or one beginning in an angioma, the prognosis is bad, if it is a simple angioma the prognosis is much better

DR ROBERT H KENNEDY said that if this is an angioma a great deal can be done with the coagulating current. It is possible to make an angioma disappear completely in a few sittings. He thought the diagnosis ought to be established by pathological study

DOCTOR PENNOYER said he hated to be pessimistic but believed the case would come to amputation. He had presented a similar case before the Surgical Section of the Academy last year, which had originally been operated upon by Doctor Peck in 1919. He had had several operations, electrocoagulation, injection treatment, and other procedures without effecting a cure. He was finally amputated in 1929. The pathology report by Dr James Ewing was malignant angioma

#### THE FISSURES OF THE LUNGS

DR FRANK B BERRY read a paper with the above title

DR ALLEN O WHIPPLE said that Doctor Berry's paper illustrated the value of a study combining experimental method with clinical problems. If more work of this type were done, using anatomical study, which has somewhat fallen into disuse as a result of the shift to physiology and chemistry, more helpful data would result. The appearance of these shadows impresses one with the quandary one would be in in trying to localize them in the lung unless one had given careful study to this subject. The difficulties to be encountered in this work are understandable. It was impossible to get stereoscopical views, but they would have been interesting. The point Doctor Whipple wished particularly to comment on was Doctor Berry's use of anatomical studies in clearing up some of these difficult clinical problems. There is a large field for investigation to be done on these lines of anatomical and embryological studies

DR J B AMBERSON (by invitation) said that the interlobar fissures in the healthy subject can often be visualized in the X-ray film, the right transverse fissure shows as a thin hair line running across the chest somewhere between the second and fourth ribs in the postero-anterior view, the oblique fissures being shown only in the lateral view. At Bellevue a knowledge of the anatomy of the fissures has been of particular value in cases where there is a question of diagnosis between lung abscess and encapsulated empyema. Sampson and Brown, in 1922, thought they detected localized inter-

## THE FISSURES OF THE LUNGS

lobar pneumothorax in many cases of pulmonary tuberculosis, but more recent studies indicate that most of these annular shadows represent tuberculous cavities within the lung. The anomalous fissure is that which divides the azygos lobe from the upper lobe on the right. This is caused by an aberrant course of the azygos vein as it turns forward to enter the vena cava. In one thousand children X-rayed at the Bellevue Yorkville Health Demonstration, this anomaly was found in seven. It is of importance as a possible point of localization of interlobar fissures. Slides were shown illustrating some of the points mentioned.

# TRANSACTIONS

## OF THE

# PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD OCTOBER 5, 1931

The Vice-President, DR JOHN SPEESE, in the Chair

CALVIN M SMYTH, JR, M D, Recorder

### SUBPHRENIC ABSCESS FOLLOWING CHOLECYSTECTOMY

DR HUBLEY R OWEN reported the case of a woman forty-six years of age, admitted to the Woman's College Hospital November 13, 1930, giving a history typical of calculous cholecystitis. The last attack of biliary colic occurred ten days prior to admission. A cigarette drain was inserted and the patient was returned to the ward in good condition. The second day after operation the temperature rose to  $102^{\circ}$ , and again on the fourth, eighth and eleventh post-operative days the temperature was elevated. During this time the pulse did not show any corresponding acceleration and during the intervening days the temperature fell to normal. On the eighteenth post-operative day she developed a typical steeple chart, the temperature running from  $98^{\circ}$  in the morning to  $102^{\circ}$  or more at night.

An X-ray taken twenty-five days after operation showed marked elevation of the right diaphragm with a small amount of fluid in the right costophrenic angle. Right diaphragm was limited in its respiratory excursion but showed some movement. These signs suggested the presence of a liver abscess. The day following this X-ray report, twenty-six days after the cholecystectomy, an incision was made below and parallel to the right costal margin. There were adhesions between the chest wall and dome of the liver and on separating these adhesions an abscess containing 50 cubic centimetres of sero-purulent material was evacuated between the dome of the liver and the diaphragm. The temperature fell to normal two days after operation and she was discharged twenty days after operation. Bacteriologic examination of the fluid evacuated showed staphylococcus aureus in pure culture.

The speaker remarked that subphrenic abscess as a complication of cholecystectomy, especially interval cholecystectomy, is apparently rare. Two cases are mentioned by DaCosta<sup>1</sup>. Whipple in a series of thirty-two subphrenic abscesses occurring at the Presbyterian Hospital, New York, reported one case following interval cholecystectomy. This patient was not drained. The abscess was opened on the sixth post-operative day. A second case followed interval cholecystectomy which was drained. A third case was that of an interval cholecystectomy with drainage which was complicated by "a brisk subhepatic hæmorrhage". An X-ray showed a high right diaphragm, but owing to the fact there was no elevation of temperature or other signs of infection the case was not operated upon and the symptoms cleared up in about ten days. Whipple thought this case undoubtedly was a collection of fluid which absorbed without suppuration. Gatewood in reporting a group of forty-one subphrenic abscesses occurring at the Presbyterian Hospital in

## DUODENAL ULCER UNUSUAL RECURRENCES

Chicago reported five cases following suppurative cholecystitis, but mentions but one case as occurring eight days after interval cholecystectomy. Grove in reporting 1,000 cases studied by Lance, states that 13 per cent were due to lesions of the gall-bladder and liver, but does not enumerate those which followed cholecystectomy. Subphrenic abscess following diseases of the biliary tract such as suppurative cholecystitis and cholangitis is stated as occurring in 5 per cent (Gatewood<sup>2</sup>), 13 per cent (Grove<sup>3</sup>) and 16 per cent (Whipple<sup>4</sup>). Graham<sup>5</sup> believes that subphrenic abscess is not an uncommon complication of non-calculous infective cholangitis.

The case now reported is the only one occurring in a series of 114 consecutive cholecystectomies performed on the author's service at the Woman's College and the Philadelphia General Hospitals. Subphrenic abscess following cholecystectomy is probably due to the result by gravity or to extension of the infection through the lymphatics. As in Whipple's case, the speaker believes that his case, although drained at the original operation, occurred as a result of a subhepatic hæmorrhage with secondary infection, probably from the stump of the cystic duct although this duct was severed with a cautery.

Doctor Owen remarked that at the present time he seldom drains cases of interval cholecystectomy. Drainage is employed, first, when there is slight controllable ooze, secondly, in cases of gross infection of the biliary tract, thirdly, in the presence of dilated common duct, and, of course, in the presence of common-duct stone. In view of the subsequent complication of the case reported, had he not drained he would have been inclined to criticize himself, but it is apparent that drainage alone does not prevent subphrenic abscess. A dry wound is imperative, as a persistent ooze of blood or bile is undoubtedly a causative factor. Every precaution should be taken to prevent any leakage from infected foci, such as infection of the cystic duct. When drainage is employed the speaker thinks that it should not be removed too early.

### REFERENCES

- <sup>1</sup> Modern Surgery, p 953
- <sup>2</sup> American Journal of Surgery, p 2, January, 1926
- <sup>3</sup> American Journal of Medical Sciences, p 398, 1930
- <sup>4</sup> Journal Medical Association of Georgia, p 69, 1928
- <sup>5</sup> Diseases of the Gall-bladder, p 216, 1928

## DUODENAL ULCER UNUSUAL RECURRENCES

DR WILLIAM J RYAN reported the case history of a man aged sixty who was first operated upon by Dr George P Muller assisted by the reporter, in December, 1915, for perforation of a duodenal ulcer. The perforation was closed by purse-string suture and a posterior gastroenterostomy made. He made a complete and uneventful recovery and was perfectly well until July, 1922, when the symptoms of ulcer returned. He was then again operated upon by Doctor Ryan, who found an ulcer at the site of the original perforation. The gastroenterostomy was functioning perfectly. The ulcer was destroyed by cautery and the defect closed in the usual manner. Recovery was again uneventful. This time the patient remained symptom-free until July, 1930.

On the evening of July 29, 1930, he was seized with agonizing pain in the upper abdomen. The pain grew worse in spite of hypodermic injections of morphine. He vomited once, having eaten a full meal four hours before the onset of the pain. He was transported sixty miles by train and admitted to the hospital approximately twelve hours after the onset of the attack.

Examination revealed board-like rigidity of the abdomen with no localized tenderness and with marked increase in the area of liver dullness. The white-blood count was 15,600 per cubic millimetre. Flat-plate and fluoroscopic X-ray examination showed the presence of free gas under the left diaphragm. A provisional diagnosis of perforated gastric ulcer was made.

At operation, under spinal anaesthesia, a perforation of the jejunum was found just below the old gastroenterostomy. A large amount of free fluid was present in the peritoneal cavity. The perforation was closed by purse-string suture and drainage established through a stab wound below the umbilicus. Recovery was uneventful except for a slight wound infection and the patient was discharged on the twenty-second post-operative day.

Doctor Ryan placed this case on record because of the rather unusual history, namely, recurrence of the original ulcer seven years after an operation for perforation and the development and subsequent perforation of a jejunal ulcer eight years after the recurrence and fifteen years after the performance of a gastroenterostomy which was functioning perfectly.

#### OSTEOCHONDRITIS DESICCANS OF THE FEMUR

DR ELDRIDGE L. ELIASON reported the case of a man twenty-three years of age, admitted to the University of Pennsylvania Hospital, February 26, 1930, with the chief complaint of pain in the left knee on outward rotation. This complaint had persisted from its origin three months before without injury or obvious cause. He stated furthermore that his knee seemed to lock of late. The knee presented no restriction of movement but was swollen and tender over its medial aspect. Rotation produced pain. An X-ray examination showed osteochondritis to be present. Arthrotomy under spinal anaesthesia was accordingly performed and the following pathology was found. A disc of bone of a dead-white color was detached from the cartilaginous surface of the lower end of the femur and suspended under a hinge formed by its attachment to the crucial ligaments posteriorly. The cavity from which it had come was partly filled with fibrous tissue. This portion of the bone was freed and removed and the joint cavity closed with interrupted sutures of chromic catgut. A posterior plaster-of-Paris splint was applied to temporarily immobilize the joint. He was discharged nine days later after an uneventful recovery. Microscopic examination of the specimen removed was reported as "Osteochondritis desiccans." Culture of the joint fluid proved negative for bacterial growth. The subsequent course has been normal in so far as his knee is concerned.

#### MULTIPLE FOREIGN BODIES IN THE GASTRO-INTESTINAL TRACT

DR V. W. MURRAY WRIGHT, by invitation, reported the case of a woman admitted to the Surgical Service of Dr. E. L. Eliason at the Philadelphia General Hospital, May 3, 1931. She complained of pain in her lower right abdominal quadrant, nausea and vomiting. As she was mentally defective her history was unreliable. She was a white girl of twenty years of age. Her lower right abdomen was rigid and tender to palpation. The greatest point of tenderness was lateral to the colon and immediately above the iliac crest.

## MULTIPLE FOREIGN BODIES IN THE GASTRO-INTESTINAL TRACT

Peristalsis was increased. The pelvic examination revealed some tenderness in the right fornix. Her leucocytes were 9,200 per cubic millimetre, and her temperature, pulse and respirations were 99.3°-90-20 respectively.

Under spinal anaesthesia a right iliac gridiron incision was made with the expectation of finding an acute retrocaecal appendicitis. The appendix, however, was found to be normal. Immediately above the lateral to the base of the appendix some exudate and adherent omentum were noticed. Elevation of the latter showed the sharpened end of a lead pencil to be protruding through the wall of the caecum. This was surrounded with a purse-string suture and the pencil was withdrawn without contamination. During her convalescence she passed four short lead pencils by bowel.

X-ray examination after operation revealed multiple parallel lines in the stomach which were taken to be lead pencils though the outlines were vague. Later attempts by bronchoscopic service to remove the lead pencils from the

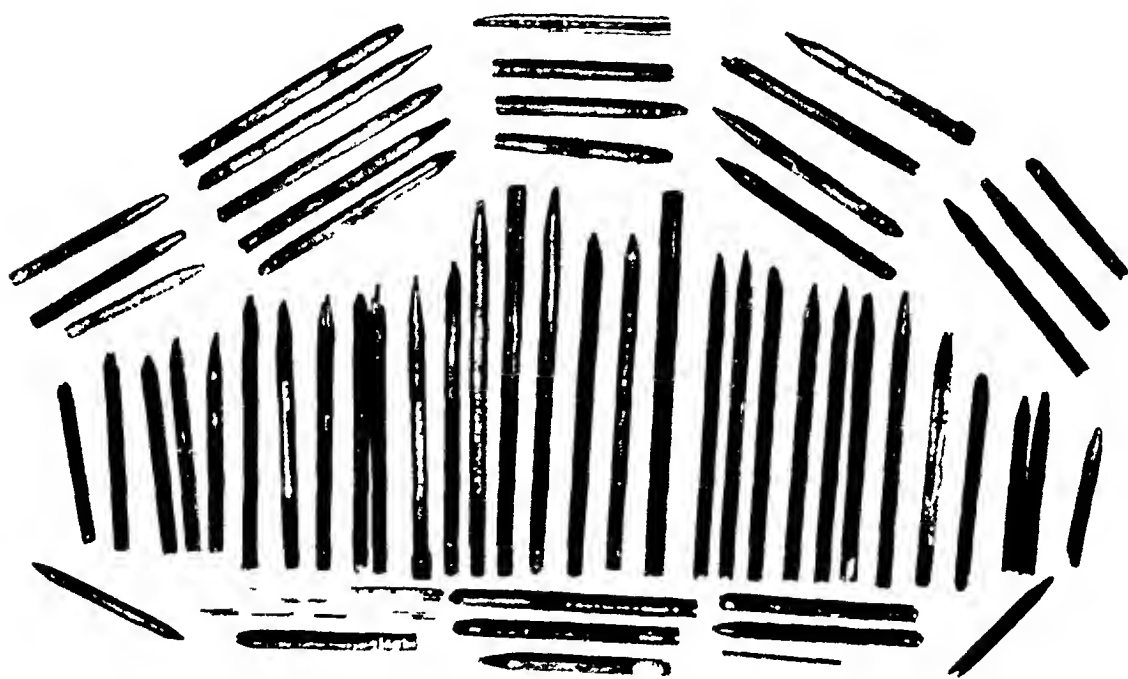


FIG. 1.—Lead pencil pieces removed from the stomach

stomach proved unsuccessful due to the fact that the weak ends of the forceps slid off the end of the pencils which were imbedded in the gastric mucosa. Subsequently a gastrotomy was performed by Doctor Eliason and forty lead pencils were removed from the stomach (Fig. 1). These were mostly imbedded between the rugae. Convalescence was uneventful. A recent follow-up call to the Byberry Insane Hospital where she is confined because of dementia praecox reveals that she is well and has not swallowed any more lead pencils to their knowledge.

DR. HUBBLY R. OWEN said that the size of some of the foreign bodies swallowed by patients is astounding. At the Philadelphia General Hospital several years ago he removed a teaspoon swallowed by an insane patient and last year removed a glass test tube. Both of these recovered. Even when foreign bodies perforate through the stomach or intestinal tract they seldom cause general peritonitis but usually such perforation is followed by a local

abscess The speaker operated upon one case and removed a foreign body from the centre of an appendiceal abscess

DR V W MURRAY WRIGHT recalled a young man who was admitted to the Philadelphia General Hospital with a diagnosis of peritonitis resulting from the perforation of a hollow viscus A "scout" X-ray plate of his abdomen revealed air under his diaphragm and two hazy parallel lines in his upper left abdomen which resembled a tongue depressor The abdomen was opened directly over this area and a walled-off abscess the size of a grapefruit was found Evacuation of the abscess revealed the end of a *tongue-depressor-swab* protruding through the jejunal wall The foreign body was removed and several drainage tubes were inserted Several days later the patient seized a nurse's thermometer and after biting it in two, swallowed the pieces The course of the two fragments was followed by X-ray until several days later when they presented themselves at the drainage opening and were readily removed He had at one time a large comminuted fracture of his skull which was trephined and had never been normal mentally since the accident

#### PERFORATION OF MECKEL'S DIVERTICULUM BY A FISH BONE

DR ADOLPH A WALKLING reported the case of a boy eight years of age, admitted May 5, 1930, to Surgical Division B of Jefferson Hospital with pain in the right lower quadrant and a temperature of 100°, pulse of 90 and respirations of 24 Two days before admission he complained to his mother of pain in the abdomen and was given a saline cathartic which was effective He vomited on the following day and the pain definitely localized in the right lower quadrant He became restless his pain was very severe and the vomiting continued until his admission He had eaten fish three days before the onset of symptoms There was no history of previous gastro-intestinal disturbance The abdomen showed slight distention and marked tenderness and rigidity in the right lower quadrant Peristalsis was heard, no masses were palpable The white-blood count was 15,000 per cubic millimetre

On opening the peritoneal cavity some turbid fluid escaped The exploring finger found a mass of small bowel adherent to the posterior peritoneum in the right iliac fossa The mass was isolated with packs and opened a small amount of pus escaped The finger then came in contact with a sharp pointed object which felt like a pin The section of ileum containing this object was brought out of the abdomen It was found to be a diverticulum of the ileum, the tip of which was gangrenous and from this gangrenous area there protruded a small bone (Fig 2) The diverticulum, which was 26 centimetres proximal to the cæcum, and its adjacent portion of the ileum were resected The appendix was also removed One small cigarette drain was carried down to the infected area and the abdomen then closed about the drain The diverticulum measured 3.5 centimetres by 5 centimetre The bone proved to be the rib of a fish

Recovery was uneventful and the patient was discharged on the fourteenth post-operative day

The reporter remarked that perforation of a Meckel's diverticulum by a fish bone has been reported only once before<sup>1</sup> This patient was operated upon in 1899 Perforation of the intestines by swallowed fish bones is ap-

## TRAUMATIC RUPTURE OF THE JEJUNUM

parently rare, but one wonders why this should be so. Fish bones are commonly swallowed but case reports on perforation are not commonly seen. Probably reasons for infrequent perforation are that either these objects are caught at some point in the pharynx or œsophagus or are surrounded by faecal matter and are as a result harmless. The large intestine is the most frequent site of perforation, the cause of which is probably the sacculations, the thin wall and the churning movements. The small intestines and stomach are rarely perforated, although there has been reported a death from gastric hæmorrhage because of perforation of the posterior wall of the stomach by a fish bone.

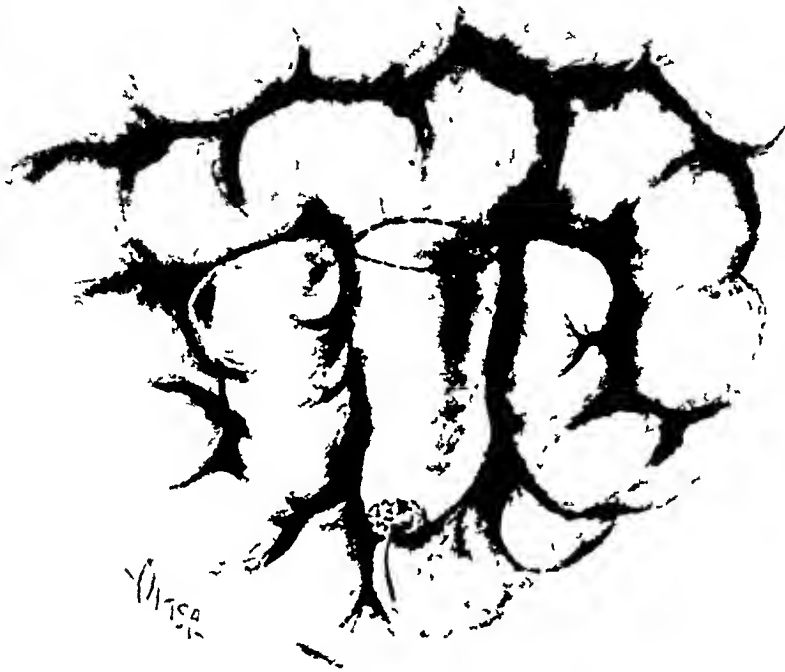


FIG. 2.—Showing diverticulum with fish bone protruding

### REFERENCE

<sup>1</sup> Blanc, H. Bull. et Mem. Soc. de Chirurg. de Paris, vol. LXXI, p. 378, 1929.

### FRACTURES OF THE PELVIS

DR WILLIAM R. GILMOUR read a paper with the above title for which see page 161.

### TRAUMATIC RUPTURE OF THE JEJUNUM

DR ELDRIDGE L. ELIASON presented a thirteen-year-old boy, who was admitted to Surgical Service C at the University of Pennsylvania Hospital May 30, 1930. He stated that he had fallen flat on his abdomen on a flat cement yard seven hours before. He further stated that three-quarters of an hour afterwards he vomited and that he developed pain in the abdomen radiating to the left shoulder. This pain became worse and was followed by chilliness and vomiting.

The temperature, pulse, respirations, on admission were 98.8°—100—36. Physical examination revealed a high right diaphragm with obliteration of



liver dullness anteriorly. His abdomen was tense, tympanitic, flat, rigid and tender. No peristalsis was visible or audible. A flat X-ray plate of the abdomen while standing up revealed considerable air beneath the right diaphragm, which was high and limited in its movements. Some fluid was noted in the right costophrenic angle. A diagnosis of ruptured intestine was made and immediate laparotomy under ether anaesthesia performed. Fluid, particles of food, and an undigested strawberry were found beneath the transverse colon. These were found to have exuded from a spiral split in the jejunal wall beginning just below the ligament of Treitz and extending downward for three to four inches. This was oversewed, a jejunostomy performed below the point of rupture and the tube was carried through a stab wound in the left flank. Drainage consisted of two cigarette drains to the jejunum and a split tube suprapubically. The abdomen was closed after thorough washing of the abdominal cavity with warm normal saline solution.

Post-operatively, a Jutte tube was placed in his stomach. The boy's convalescence was perfectly smooth for five or six days. Then when liquids were given *per os* it became stormy due to regurgitation of food caused probably by the jejunostomy tube occluding the jejunum. As soon as the tube was removed he convalesced rapidly. An X-ray examination one week after operation showed some hesitation of the barium in the region of the jejunum. Following his discharge from the hospital the boy remained normal except for occasional slight abdominal pain until six months later when he was re-admitted after being hit in the stomach by another boy. He was confined to the hospital for two days and then returned home. An X-ray examination at that time revealed slight stasis of the jejunum.

DR DAMON B. PREIGER said the ordinary history in rupture of the jejunum is a sharp blow. He recalled an exactly similar case in which the patient was thrown off a circular saw and as Doctor Eliason said, it seems a rather common way for these injuries to be sustained. Another case in which he played an inglorious part at the Presbyterian Hospital several years ago, was that of a very large fat woman who had fallen on the flat of her back as she was going up steps. The history was clear and definite. Her daughter said she fell over backwards on account of pain in the abdomen. She did not look as though she was bleeding and falling on the flat of her back he thought she probably had an injury to the back which referred pain to the abdominal area, she was therefore not operated upon at once, but later developed all the classical signs of intestinal perforation.

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STATED MEETING HELD NOVEMBER 2, 1931

The President, DR. GEORGE P. MULLER, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

HÆMOPERITONEUM—PROBABLE SPLENIC ORIGIN

DR. EDWARD B. HODGE and (by invitation) DR. ROBERT S. ALSTON, presented an Italian man, aged forty-nine, who was admitted to the Germantown Hospital December 15, 1929, complaining of severe abdominal pain. He stated he had retired as usual the night before and was awakened about 5 A.M. by an agonizing pain in the upper abdomen. It was not a sharp pain but a terrible ache getting worse and worse until his abdomen became very

hard, he vomited once, an injection of morphia caused sleep for a few hours, on awaking he still had great pain and his abdomen was even harder. Now he sought hospital treatment, when admitted to the ward he seemed in great pain, was apprehensive, restless and shocked, but perfectly conscious and rational. The striking thing about him was the board-like rigidity of the abdomen. Percussion over the abdomen was tympanitic with some movable dullness in the flanks. There was no especial area of tenderness. The abdomen was so hard nothing could be felt through it. Peristalsis slightly diminished was heard throughout the abdomen. His chest was clear, his heart compensating, his blood-pressure was 80/50. He had no complaints as to his previous health and denied any blows to his abdomen. He was operated upon in this hospital three months ago when a gangrenous appendix was removed without any complications. He then had a normal convalescence, was discharged in good condition, and remained well until this attack. His appetite was good. His bowels were regular and he had a normal movement the day before. His past medical history was negative for both malaria and typhoid fever.

*Laboratory Findings*—Red blood-cells, 2,900,000, white blood-cells, 12,800, hæmoglobin, 52 per cent. Differential count, normal. Temperature pulse, respirations, 97-96-30. Urine negative.

When the abdomen was opened, through a high right rectus incision, there was a gush of bright blood and small clots floated into the wound. When the flow of blood was controlled, exploration of the peritoneal cavity revealed no bleeding point, the spleen was about four times its normal size, very soft and congested but not grossly bleeding. There were two denuded areas on its under surface near the hilum. These were not bleeding and were thought to be caused by handling. Most of the clots in the abdomen were congregated in the upper left quadrant but removing them caused no fresh hæmorrhage. The whole abdominal cavity was then packed with gauze to absorb all the free blood and these were allowed to remain for a time. Then a second careful search was made for a bleeding point. This proved unavailing and it was decided to close the abdomen and treat the patient expectantly.

After a somewhat stormy convalescence he was discharged on the sixteenth day with a blood count of 4,730,000 red blood-cells, 12,100 white blood-cells, 75 per cent hæmoglobin, and a normal differential count. During his stay in the hospital the following laboratory tests were made. *Cell morphology*, variance in size and shape of red blood-cells, otherwise negative. *Parasites*, negative for malaria and typhoid on several occasions. *Platelet count*, 320,000 per cubic millimetre. *Coagulation time*, four minutes and ten seconds. *Bleeding time* less than one minute. *Fragility of red cells*, hæmolysis begins at 0.425 per cent, is complete at 0.35 per cent. *Vandenberg test*, direct method, negative direct reaction, indirect method, four units strength of bilirubin 2.0 milligrams per liter. *Widal*, negative.

At present, the spleen is markedly enlarged, reaching to the umbilicus. The blood count now shows red cells, 5,800,000, white cells, 10,700, hæmoglobin, 96 per cent, indicating the development of a polycythæmia. He feels perfectly well.

The speaker remarked that hæmoperitoneum from spontaneous rupture of diseased spleens either in the course of an acute illness or at some time thereafter is more often reported than spontaneous rupture of normal spleens. An article in the *British Surgical Journal*, in 1930, by H. Bailey on Spontaneous Rupture in the Normal Spleen cites only eleven cases to date.

The first was published in 1919. Of the eleven cases nine were males ranging from sixteen to fifty-three years of age and two were females aged twenty-seven and thirty-five respectively. All of these cases were treated by splenectomy and the microscopical reports showed in all cases examined normal splenic tissue. In four cases no tissue examination was made. In this series seven recovered and four died. There was no consistent site of rupture. T. S. Jackson reported a case at first thought to be spontaneous rupture in a fifteen-year-old girl who was seized while sitting in the theatre but later found that she had been forcibly thrown against a desk just four weeks before. Microscopically, the spleen was normal. The case was reported to show the long interval between the blow and the rupture.

Of spontaneous rupture in diseased spleens there is more written. Berger collected a series of 123 cases in 1927. Of these, ninety-nine were malarial. This picture is also common in parts of Italy, where malaria exists. Wohl reported another series of twenty-eight cases where rupture occurred spontaneously in the course of acute disease. Fourteen of these were in typhoid fever. There was also a series reported by Pyrah, Stansfield and Garland of three cases of ruptured splenic vein in disease where both the liver and spleen were enlarged. In 1853, Bowie reported in the *Bombay Journal* a case of spontaneous rupture in the course of common continued fever. This was a necropsy finding. In 1882, Calkins reported in the *Michigan Journal* a case of rupture thirteen years after acute malaria in which the spleen had remained large. This was another necropsy finding.

The reasons advanced for rupture in malarial and typhoid spleens are (1) Softening of the spleen, (2) engorgement of the spleen, (3) blood forced between the splenic tissue and the peritoneal covering, and (4) perisplenic adhesions fixing a large, soft, engorged organ. All agreed the picture was the same in traumatic and spontaneous rupture except for the blow. Several points were stressed as aids in diagnosis, the development after a few hours of pain in the left shoulder and its persistence, and the fact that in gastro-intestinal ruptures there is rarely vomiting while in hæmoperitoneum there is commonly vomiting. The treatment advanced was splenectomy or suture, never tampon packing except as an emergency measure. In the case reported there was hæmoperitoneum of probably splenic origin with recovery without splenectomy or suture.

DR CALVIN M. SMYTH, JR., said that in 1924 he and Dr. Damon B. Pfeiffer reported a number of cases of rupture of the spleen before this academy. These cases were all traumatic, but traumatic rupture and spontaneous rupture differ more in etiology than in symptomatology. In spite of the fact that the reporters had not been able to demonstrate a lesion in the spleen in this case, it is quite possible that a small tear was present in the splenic pulp. These tears are often very hard to locate, especially with the abdomen full of blood and the patient in bad condition. The interesting thing about this case is that in the course of two years there has been a

## SARCOMA OF THE UPPER END OF THE HUMERUS

marked increase in the enlargement of the spleen without symptoms but with the apparent development of a polycythæmia Pemberton has recently stated that enlarged spleens in the absence of definite etiology should be considered as instances of the splenomegaly of potential splenic anæmia and advised operation It seemed to the speaker that this was such a case and he believed that this man should have his spleen removed before the development of further trouble

## SARCOMA OF THE UPPER END OF THE HUMERUS

DR RUTHERFORD JOHN presented a man, aged forty-two, who was first seen June 23, 1924, complaining of pain in the right shoulder for previous six months Some years ago he had erysipelas in the right hand, typhoid fever in 1910, mild attack of pneumonia in 1917 General health otherwise has always been good, habits regular Had Neisserian infection in 1910, lasting for a few weeks

About six weeks after the pain started, a swelling in the region of the head of the right humerus was noticeable No history of injury except that four or five years ago he was struck on the shoulder while boxing He was a fairly well-nourished and well-developed adult male, general appearance of health and vigor The right upper extremity showed swelling about the lateral surface of the head of the right humerus the size of a small lemon, there was slight local elevation of temperature, no tenderness, but pain in the shoulder and down the arm, worse at night The shoulder joint was fixed in slight abduction X-ray examination showed in the head of the humerus a cauliflower cystic-like appearance, the shaft down to its middle had a moth-eaten appearance with periosteal proliferation At one place there seems to be new bone laid down on the shaft The possibility of lues caused blood Wassermann to be made at this time, which was negative The tumor steadily increased in size until October 6, 1924, when an X-ray showed "a huge swelling now present involving the outer upper portion of the humerus which is of the same density as the other soft parts There has been more absorption of the upper portion of the shaft The hazy areas extend well down the shaft, through its middle third The periosteum has a distinctly fuzzy appearance In the upper third there seem to be distinct perpendicular striations A diagnosis of sarcoma was now made

Deep X-ray therapy was started which relieved the patient's pain His general health continued good, his shoulder-joint remaining stiff but with only twinges of pain on changes in the weather Repeated X-rays showed the process extending downward along the shaft of the humerus, being most active in the middle third Has been averaging one X-ray treatment per month March 11, 1931, he was subjected to biopsy, in the course of which the bone was found to be so hard and sclerosed that a few chips were removed with a gouge and mallet with difficulty The wound healed quickly by first intention No diagnosis was made on the tissue removed, it being reported as unsatisfactory for examination

From this time until June 17, 1931, the tumor in the upper third of the arm enlarged rapidly It was lobulated, fairly firm, and not adherent to the skin Along the line of the first incision the mass had softened, pointed and was near to rupture At operation date, a large amount of fairly well encapsulated, lobulated, gray, friable material was removed from the soft parts, from which it was easily freed by blunt dissection, giving the impression of having grown from a deeper layer by pushing the muscle tissue apart This

tumor was not adherent to the bone nor did it appear to arise from it. The bone itself was found as dense and hard as on the previous examination. Dr. C. Y. White's report on this tissue is as follows: "The bone specimen shows in two small areas infiltration of a doubtful sarcoma involvement, unable to make a better or more definite diagnosis. The soft tissue shows mixed cell sarcoma." Smear and culture negative. X-rays of all long bones and lungs failed to show evidence of metastasis.

In spite of the laboratory diagnosis of sarcoma no amputation was done. The patient's general condition was excellent, he had no pain. The X-ray showed involvement of the glenoid cavity of the scapula and of the outer end of the clavicle. An amputation would have meant a very serious shoulder-girdle amputation and Doctor John felt that if there were other involvement that it most certainly had occurred in these eight years. The patient was sent away for six weeks with no treatment. On September 21, 1931, he returned, having gained seven pounds and looking the picture of health. The operative line was slightly inflamed and the soft parts almost as large as before the removal of tissue in June, but the patient had no pain. After one deep X-ray therapy most of the mass in the soft parts disappeared. The inflammation about the incision has cleared up except for one small area at the centre of the incision, which is scabbed over. The patient is back at work and feels perfectly well.

DR. EDWARD T. CROSSAN wondered whether this was a sarcoma or ever was a sarcoma. The microscopical slides suggest an epithelioma, and, clinically, it has acted like one. To assume this to be a sarcoma, to assume that the X-ray has made it disappear, to assume that the man has been alive for eight years, and that he has had a biopsy without growth in the scar, is almost too much to believe.

DR. JOHN said that he gave the diagnosis with a question mark for the very reasons that Doctor Crossan had brought out. Microscopical slides were sent to two laboratories, also a specimen was sent to Baltimore and the diagnosis of sarcoma was made by all three, so there were three laboratory reports contrasting with the clinical picture as seen at this time.

#### SARCOMA DEVELOPING IN A RECENTLY FRACTURED NECK OF THE FEMUR

DR. T. TURNER THOMAS reported the case of a woman, sixty-eight years of age, who, on December 25, 1929, fell, injuring her left hip. The following morning she was admitted to the Northeastern Hospital, where the X-ray disclosed an intertrochanteric fracture of the left femoral neck with the detachment of a separate large fragment carrying the lesser trochanter. The left lower extremity lay helpless in eversion and shortened.

December 26, under light ether anaesthesia, a Whitman abduction case was applied from the chest to the ankle. The patient suffered little or no pain or discomfort. She was taken home in her immobilizing apparatus two weeks after the accident. The after course continued uneventfully. The plaster case was removed at the end of seven weeks. After two more weeks she was permitted to sit out of bed for short periods daily and three weeks later was permitted to stand up with crutches and soon to take a few steps. At this time there was evidence of what was interpreted to be an excessive mass of callus in the fracture area. Even then she did not acknowledge

Fig. 1—Intertrochanteric fracture of neck of femur  
One day after accident



Fig. 2—Same case two days after accident and one day after reduction by Whitman abduction brace



Fig. 3—Same case four months and two weeks after accident, showing evidence of sarcoma



any pain except in certain positions of the limb. She probably had more than she complained of. During the following three or four weeks the patient was kept in bed with the hope that if it was callus it would slowly subside with rest. On the advice of her surgeon, Doctor Thomas, however, she returned to the hospital for X-rays of the mass and was admitted to the Philadelphia General Hospital May 5, 1929.

At no time did the mass feel like a well-defined encapsulated tumor. It seemed to be an ill-defined infiltration of the tissues about the fracture which could be felt as an irregular hard mass close to the skin. The patient at no time showed more weakness than might be expected in as thin a person with a fracture of the neck of the femur. The reporter visited her in the hospital on the day after admission and found her in about the same condition as when she left home. But a day or two later when she was taken to the X-ray department and numerous films were taken, she collapsed. She died May 9, 1931. At post-mortem widespread metastases to the lungs were found. The heads of the X-ray department of the University Hospital, after examination of the X-ray films taken at the Northeastern and Philadelphia General Hospitals, have diagnosed sarcoma, probably enchondrosarcoma. They incline to believe that it was present before the fracture and that this was, therefore, a pathological fracture. They agree that probably no roentgenologist would have diagnosed a pathological fracture at that time. Their evidence is a slight concentration of bone in one of the fragments near the fracture line. They also said that X-ray films of similar cases are very rare. At the Philadelphia General Hospital the autopsy diagnosis was osteogenic sarcoma of the left femur with metastasis to both lungs. The X-ray diagnosis of the lung condition was chronic ulcerative tuberculosis of both lungs.

#### FORWARD DISLOCATION OF THE KNEE

DR. FREDERICK R. ROBBINS reported the case of a colored man, thirty-eight years of age, who was admitted to the Pennsylvania Hospital September 8, 1924, on account of an injury to his right knee. The right knee showed a large recession to the left and over the patellar region with a bulging in the popliteal space, where the condyles of the femur could be felt protruding and stretching the skin. Above the head of the tibia the patella was lying loosely and recessed well below the level of the anterior edge of the tibia. The foot was warm and dorsalis pedis and posterior tibial pulse could be palpated. An X-ray examination showed a forward dislocation of the right knee-joint with the remarkable features that there appeared to have been no avulsion of the spine of the tibia, nor any evidence that any bone had been detached at the attachment of the crucial ligaments to the femur.

Under gas-ether anæsthesia an immediate closed reduction was done. The right thigh was slightly flexed and supported on sand bags. Extension was applied to leg with very slight over-extension of leg on thigh, combined with pressure upward and backward on condyles of femur, pressure downward and forward on head of tibia with a simultaneous pull on the leg. The head of the tibia could be felt and heard to slide into place with a soft click. A posterior splint was applied.

On the third day after reduction another X-ray examination showed that the normal relation of the bones of the right knee had been established. On the fourth day there was slight swelling of the knee with fluctuation, ecchymosis extended from knee to hip on posterior surface of the thigh. The patient complained of pain in the knee and abdomen at night. The twelfth day after admission, the patient signed a release and walked home, with

## FORWARD DISLOCATION OF THE KNEE

partial aid of crutches. Two months later the patient was reached through the Social Service. He refused to come back to the hospital. At that time he was walking well, using a short cane. The fact that the patient had a positive Wassermann did not delay convalescence.

The speaker added that complete forward dislocation of the knee is rare. Reduction is easy, although a general anæsthetic is always advisable. The reduction should be done promptly, but if possible X-ray should be taken first. He advised a relatively short fixation on a splint, with early physiotherapy, heliotherapy and passive motion. Surprisingly good results are reported when the injury is extensive, and when function is reestablished early.

In the last ten years, 63,248 patients were admitted to the Pennsylvania Hospital, of which number there was but one dislocation of the knee. In the last eight years, 76,983 patients were admitted to the Graduate Hospital of the University of Pennsylvania, with one incomplete lateral dislocation of the knee, and in the last four years, 13,230 patients were admitted to the Bryn Mawr Hospital, with one incomplete lateral dislocation of the knee. Each of these general hospitals has a large traumatic surgical service, where dislocations should be relatively frequent. Yet, in over 150,000 admissions, there was only one complete dislocation of the knee. Since the dislocation is produced by some severe type of violence, the condition of the vessels and nerves distal to the seat of the injury should always be determined. Forward, posterior, mesial, lateral, and rotary types have been distinguished, the term being used to describe the position of the leg with reference to the femur. In 1909, 270 cases of dislocation were reported, 114 being of the forward type. Several cases have been reported since.

Platt reports two cases. First, a twenty-year-old girl, who, while crossing a dark field, slipped, caught her left foot in a hole and fell over backward on the left side. The dislocation was reduced, posterior splint applied for ten days and plaster-of-Paris for five months. The result was complete ankylosis in full extension. The second was a man, forty-seven years of age, with forward dislocation, which was easily reduced. A plaster case was kept applied for four months. Eleven months later the knee was painless with 20° range of flexion, and abnormal lateral mobility. In the opinion of the speaker, these two patients were immobilized for too long a time. Ransohoff reports three dislocations of the knee in twenty-eight years at the Cincinnati Hospital. In a too rapid fall of a mine shaft elevator, five out of eighteen occupants sustained forward dislocation of the knee. All recovered and were soon at full-time work. Herring reports a similar accident of six miners in a shaft, three sustaining forward dislocation. In two of these cases amputation was necessary, due to gangrene following injury to the popliteal vessels. Stetter reports a case where a soldier, running down hill, suddenly straightened up to salute an officer, and at once collapsed with a posterior dislocation of the knee. Haidoum reports the necessity of twelve amputations in twenty-seven posterior dislocations, because of vessel injury. Open operation is occasionally necessary for reduction. Gilbert reports a case of forward dislocation which was reduced and patient insisted on leaving the hospital on the second day. He walked as well as ever without dis-



comfort wearing an elastic bandage. He returned to work on the twentieth day.

# TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR

DR A BRUCE GILL read a paper with the above title

DR GEORGE M DORRANCE remarked that the results of a second series of intracapsular fractures of the femur were not as satisfactory as his first series. Most of the patients were over sixty years of age. Recently the speaker examined a number of these patients who had union and was surprised that several of them had pain in the hip. He has had no experience with the Whitman reconstruction operation as it never seemed correct to him either from an anatomical or physiological standpoint. The arthrodesis seems to be a distinct advance in the treatment of some of these cases.

DR J TORRANCE RUGH remarked that going back over his own experience he is forced to conclude that each case must be treated individually. He does not believe it possible to lay down any exact rules regarding united fractures of the hip. It is quite generally admitted that in the younger patients and up to sixty years of age the Whitman abduction method gives better results than any other procedure, and yet it is not a universal method of treatment. Any set rule is going to meet with disaster in case after case and one is forced to select the treatment according to the condition of the moment. One hears a great deal about absorption of the head and the neck and implicit reliance is placed on the X-rays for the determination of the degree. The speaker does not believe this reliance is constantly justified. He has, on several occasions, cut down upon a femoral head said to be almost entirely absorbed to find it quite hard and holding firmly a bone-graft placed in it through the femoral neck. He is a little more in favor of the bone-graft for fixation of cases of non-union and has obtained better results from this method than by any other line of treatment.

# THE USE OF POTASSIUM IODIDE IN HYPERTHYROIDISM

DR CHARLES H FRAZIER read a paper with the above title

# BRIEF COMMUNICATIONS

## GANGRENE OF THE STOMACH\*

CASE I—*Gangrene of the Stomach* The patient, a member of the Police Department of the city of New York, thirty-five years of age, was a man of exceptionally good habits and fine physique. He had never had any serious illness. On Sunday, November 3, his tour of duty permitted him to be home for his mid-day meal. For this meal his wife cooked a duck which was said to have come from a farm on Long Island. It was undrawn and the contents of the gizzard, together with all of the entrails, were still in the fowl when it was purchased. Subsequent inquiry failed to obtain any further information as to when the duck was killed, or how long it had been kept on ice. Poultry sold by this butcher came into his possession through cold-storage warehouses. The time allowed for dinner was short and the patient was hungry. He ate heartily of the duck, and in considerable haste, and then reported for duty. Two hours later, while on post, a sudden attack of diarrhœa occurred, and several times during the afternoon and evening he had similar profuse diarrhœal stools. The odor of his stools, as he described it, "being very much like something that had been dead for a long time."

Shortly after the diarrhœa began, vomiting also occurred and portions of the duck were regurgitated which had a most offensive odor and taste. No other members of the family were affected.

At ten o'clock in the evening nausea and vomiting began in a much more active form and lasted more or less continuously until five o'clock in the morning. The diarrhœa was also continuous and the stools were very offensive. He reported sick on Monday morning, November 4. I, the police surgeon of his precinct, first saw him professionally about two o'clock on the same day. His temperature at that time was 97.6°. An hour after I saw him, his family physician called and found the temperature to be 104.2°. At three o'clock in the afternoon, soon after this, he had a chill which was so severe that he shook the bed. This continued for about ten minutes and at four o'clock his temperature was 105°. He was in a condition of stupor by this time and could remember little, if anything, of the events of that day.

Tuesday, November 5, his temperature was normal in the morning, but a chill occurred about every four hours, sometimes of extreme violence. Each chill lasted from five to ten minutes. Chills continued during the week, but lessened in severity, although the four-hour intervals remained essentially the same. After each chill, the temperature rose to 103°, or even to 105°, and then within an hour fell to normal or nearly so.

Although far from well, circumstances compelled him to report for duty again on the morning of the 11th of November. During the day he had two chills at a two-hour interval. When seen by me in the afternoon the abdomen was soft, there was no rigidity on either side and no point of tenderness could be found, after a most careful examination. His diet was restricted to fluids only. He was seen again on the 15th of November and had had no chill since the 13th. No solid food had been taken during the previous forty-eight hours. He had taken, however, 1½ quarts of seltzer, mixed with orange juice, to relieve his excessive thirst. Asked for a swallow or two of water every two minutes and complained of a burning sensation in his throat, which was relieved somewhat by the passage of the cold drink. Nausea persisted. There was no point of local tenderness in the abdomen. Neither rectus muscle showed any rigidity. Temperature ranged from 99 to 100° and the patient's general condition appeared to be somewhat improved.

On the 16th of November, the condition of the patient was less favorable. Some tenderness developed in the right lower quadrant of the abdomen and there was slight

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\* Read before the Association of the Alumni of the Methodist Episcopal Hospital of Brooklyn, N. Y., January 22, 1931.

rigidity of the right rectus muscle. The exact diagnosis was still in doubt, but it was evident that hospital care was indicated, and on the morning of the 17th, he was admitted to the German Hospital of Brooklyn, in the service of Dr James Peter Warbasse.

At the time of his admission, the symptoms just mentioned had become accentuated. There was a definite rigidity over the right side, the legs were drawn up and there was tenderness over the entire right lower quadrant. The leucocyte count showed 23,600 cells with 80 per cent polymorphonuclears.

The pulse was 108, respiration 28, and temperature  $102.2^{\circ}$ . He was prepared for an immediate operation, taken to the operating room and operated upon at once by Doctor Warbasse. Upon opening the abdomen, through the usual right-curved incision, a large retroperitoneal abscess was discovered lying behind the descending colon. The posterior wall of the intestine formed a part of the abscess wall, but the exact point of infection could not be definitely determined. The abscess cavity was extensive in area, but had burrowed behind the peritoneum and did not produce a definite tumor mass which could be palpated, notwithstanding the fact that about one-half pint of pus escaped through the operation wound. The pus was pale blue in color and later, on the subsequent dressings, where the discharge had become exposed to the air for a short time, there was a very definite blue color to the discharge—quite characteristic of an infection caused by the *Bacillus pyocyaneus*. A second wound was made in the posterior aspect of the right flank and two drainage tubes were inserted, the one in the anterior wound, the other in the posterior one. The appendix was congested and discolored, but had not ruptured. The head of the cæcum and a portion of the posterior wall of the descending colon was in the same condition. Whether the actual point of infection came from the appendix, or through the lymphatic channels of the mesentery of either the small or the large intestine, could not be definitely determined.

The patient returned from the operating room in good condition. Vomiting continued, from time to time, the vomitus was a brown fluid. He complained of great thirst and of an area of soreness and of burning on the right side of the sternum and over the entire epigastric region.

The subsequent progress of the case was most unsatisfactory. On the 18th, the leucocyte count was reduced to 18,000 cells, the proportion of the polymorphonuclears remained as before. His temperature varied from  $98.8^{\circ}$  to  $100.8^{\circ}$ . Lavage was given from time to time. Feeding by the stomach was discontinued and nutrient enemata were substituted. These were not well retained at first, since hiccoughs soon developed in addition to his nausea and vomiting. A daily blood count was continued, and on the 21st there were 31,400 leucocyte cells reported, with 90 per cent of polymorphonuclears. The hiccoughs became continuous, most of the time. After a day or two a mild delirium began. The drainage from the wound through both tubes continued, and the gauze, surrounding the area of the wound discharge, was surrounded by a halo of a light blue color, about one-half inch or more in width. The nausea, vomiting and hiccoughs continued and steadily grew worse. The wound, on the other hand, continued to drain well and the temperature steadily subsided. The nutrient enemata were well retained, and his bowels moved regularly once or twice a day, though sometimes the stools were involuntary. The blood count which was made daily showed no material change from that already noted.

On the 29th of November, he vomited about an ounce of dark red blood. Several times during the day, similar attacks of vomiting occurred of one to three ounces of dark red blood. During the afternoon of this day, he became steadily worse, and shortly after midnight, he died.

At autopsy, the following conditions were found, the notes of which I made myself.

The body shows a fair degree of nourishment, although there is a considerable loss of weight from that which existed at the beginning of his illness. There is a slight icterus but no œdema. The primary wound of operation, four inches in length and oblique in direction, exists in the right iliac region. The walls of the abscess cavity are of a deep black color, and look as if an active caustic had been used. A superficial gangrene

## GANGRENE OF THE STOMACH

of all the surface was present There is no pus in the abscess cavity and the drainage had been free and complete

The lungs show a moderate degree of hypostatic congestion in the dependent portions

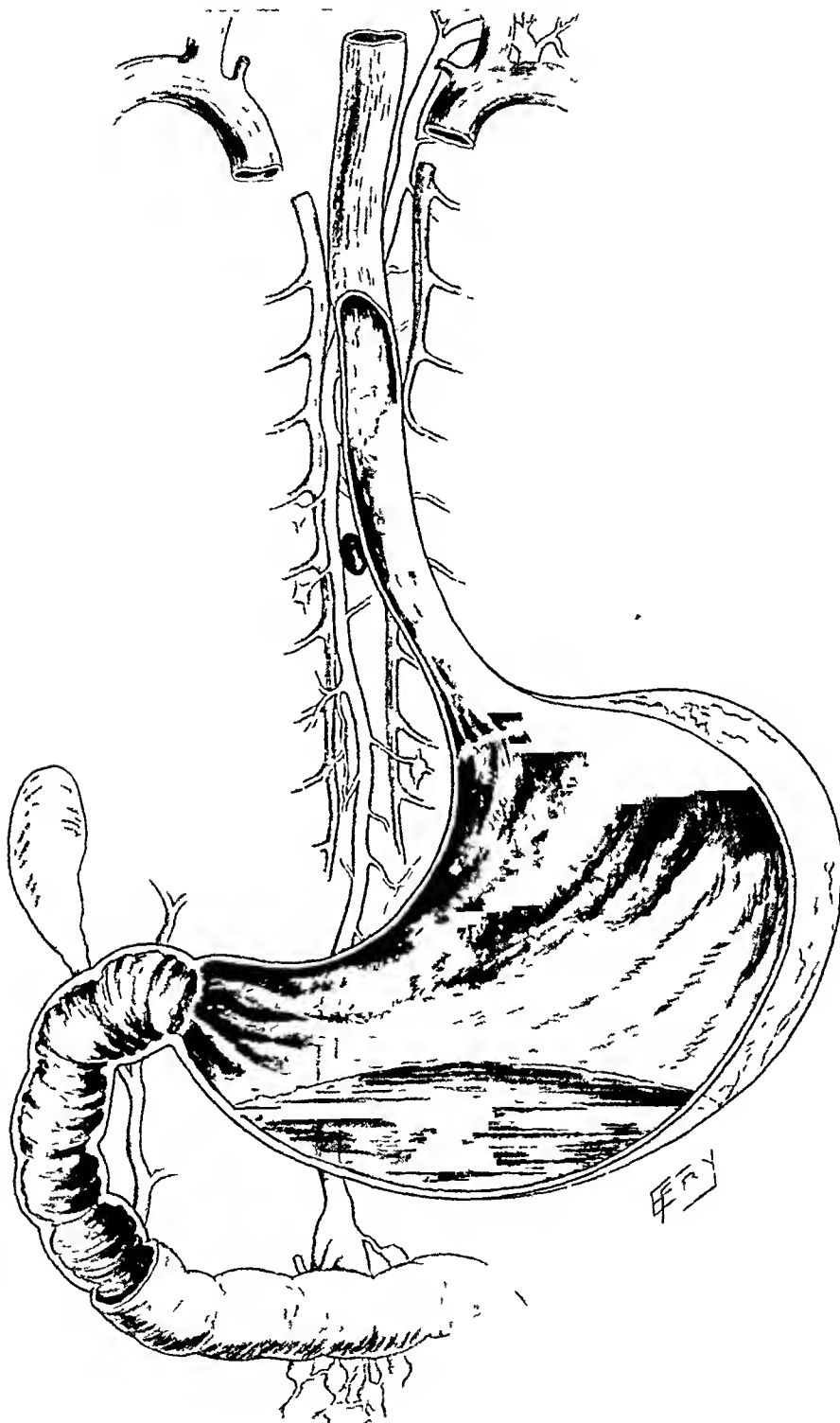


FIG 1—Sloughing of the entire mucous membrane of half of the œsophagus and all of the stomach Death from capillary hemorrhage

of both sides Both lungs are otherwise normal and show no evidence of pleurisy, pneumonia, or tuberculosis The heart is entirely normal The liver is somewhat enlarged and shows a considerable amount of fatty infiltration It presents no abnormalities The spleen is of normal size, of firm consistence, and of normal structure The bladder is

slightly distended with urine. There is no lesion of the bladder walls. Both the urethra and ureters are normal. The kidneys are both swollen and show a moderate degree of congestion. The pelvis of each kidney is normal.

The stomach is moderately distended. Upon incision it is found to contain over a quart of a dark, almost black fluid, which upon careful examination is found to be composed of equal parts of venous and of partially digested blood. This has the same peculiarly offensive odor which characterized the wound discharges during life, and which must have occasioned the statement, so often made by the patient, that he was vomiting material which tasted and smelled exactly as if it came from the wound itself. Upon lifting the stomach from its position in the abdominal cavity, the slight effort used to raise it caused the stomach to tear off at the entrance of the œsophagus. Further examination shows that *the mucous membrane of the caudal half of the œsophagus and of the cephalic half of the stomach is black and completely gangrenous*. It has sloughed off from the muscular walls of the stomach in a number of places and from the capillaries of these denuded areas has occurred the hæmorrhage into the stomach which was the primary cause of death. The muscular walls of the stomach and of the œsophagus ectad of the gangrenous mucous membranes, are very friable and tear upon the slightest tension. The small and large intestines were normal.

After the removal of the intestines the abscess cavity was carefully dissected out. It was found to take its origin close to the right of the median line on the level of the second lumbar vertebra, but the receptaculum chylî from which it is supposed that the infection started could not be satisfactorily demonstrated.

The appendix also could not be positively identified. A small fragment dorsad of the cecum and lying upon the ventral wall of the abscess cavity is all that is found to represent the probable remains of the appendix. This was entirely extra-peritoneal.

The thoracic duct is carefully followed from the diaphragm, cephalad, into the neck. In gross appearance it is not distended, nor does it show any evidence of direct suppurative inflammation. Between it and the œsophagus, contiguous to the gangrenous area in the œsophagus itself is a small gland, one centimetre in length, which is quite black and necrotic in structure. Direct communication between the œsophagus and the gland, or between the gland and the thoracic duct, cannot be established, although minute channels of infection could easily have existed between them.

Cause of death.—Primary. Acute gangrene of the mucous membrane of the œsophagus and stomach, with resulting capillary hæmorrhage into the stomach.

Secondary causes.—Acute suppurative infection of the post-peritoneal tissues, arising primarily either from the receptaculum chylî or from the appendix.

The micro-organism in each location is the same (*Bacillus pyocyaneus*). Gangrene resulted in each instance.

So far as I can ascertain, this case is unique. There is, therefore, no bibliography to be appended and no references to be cited. The nearest approach to any similar condition which I can find, was in the case of "Acute Suppurative Inflammation of the Thoracic Duct," reported by myself in 1907, published in the *New York State Journal of Medicine* in the same year, and later included in Osler's "Encyclopedia of Medicine." The *Bacillus pyocyaneus* was the active cause of the infection in each case whereas in the case to which I have just referred, the infection travelled from the stomach or œsophagus to the thoracic duct and infected it. In the present case, the bacilli appeared to have started on a similar course, but the infection reached the post-peritoneal tissues only and also the submucous membrane of the stomach itself.

HENRY PELOUZÉ DE FOREST, M.D.,  
New York, N. Y.

## INSTRUMENT FOR SUBCUTANEOUS REMOVAL OF FASCIA LATA STRIPS FOR SUTURE PURPOSES

ALTHOUGH the use of long strips of fascia lata as a living suture has proved of great value in many operations for the repair of various kinds of herniæ and injuries to joints, a strong deterrent from such an operation, in

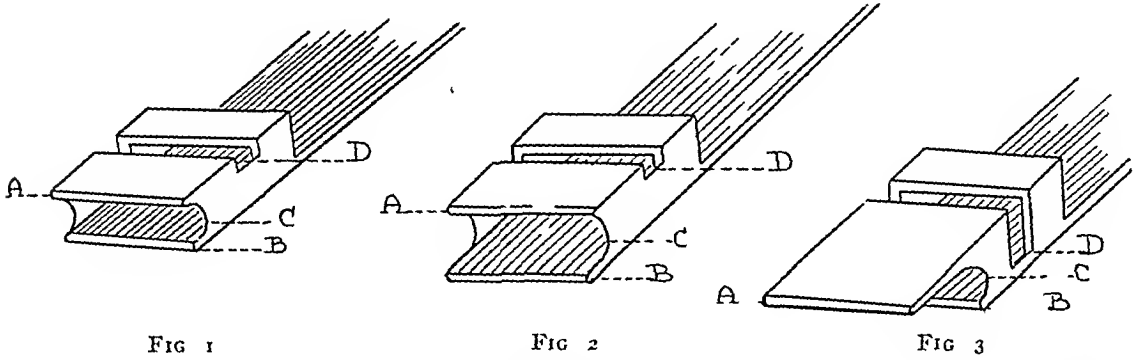


FIG 1—A—Blunt anterior edge of slot B—Blunt posterior edge C—Concave cutting edge on each side of slot D—Groove cut through the top of slot to allow insertion of sharp pointed knife in order to sever the distal end of fascia strip

FIG 2—B—The lower blunt edge of the slot protrudes a millimetre and a half or two millimetres in order to separate the under surface of the fascia first and thus force the upper blunt edge to lie snugly against the outer surface of the fascia

FIG 3—A—Modification showing the upper edge protruding instead of the lower This may be an advantage in case the other types do not strip the fascia easily D—Showing modification with the groove cut through the top and sides of the slot The type shown in Fig 1 protects the adnexa better

the patient's point of view, is a long ugly scar extending the length of the thigh

For the past six years we have thought that an instrument which would strip this fascia out subcutaneously would be a useful adjunct to our armamentarium As no suitable case, in which to use this method, came under our care, we did not crystallize the idea into instrumental form until re-

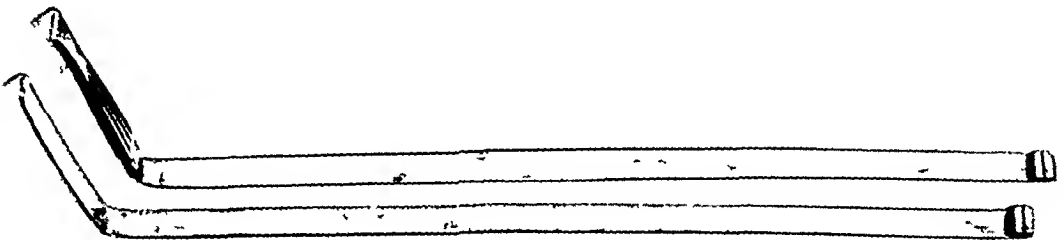


FIG 4—Photograph of instrument in experimental form

cently Our plan is to make a small incision over the upper portion of the iliotibial band of fascia lata and thread a piece of fascia in a small slot at one end of a narrow ribbon of spring steel While the end of the piece of fascia which has been threaded in the slot is held taut, the slot is pushed toward the distal part of the iliotibial band When a strip of fascia of sufficient length has been separated, a pointed knife can be inserted through the skin until it engages in a second slot which is just behind the cutting slot and perpendicular to it This slot guides the knife point so that the fascial

strip can be severed from its distal attachment without injury to adjacent structures

The dimensions of the cutting slot can be varied according to the width of fascia desired

The fascia stripper has been given an extended trial at St Luke's Hos-

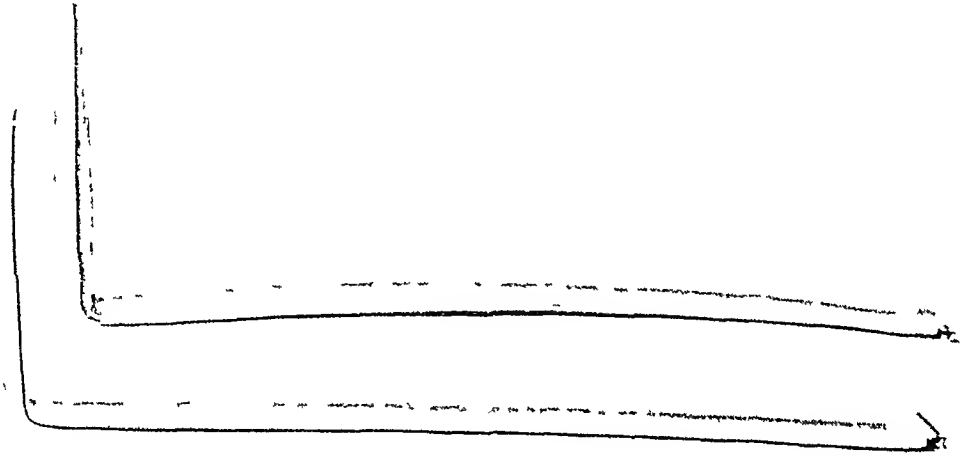


FIG 5—Photograph of instrument in experimental form

pital, New York City, on the service of Dr H H M Lyle, and found to be most practical. It is simple in construction, easy of application, and produces an ideal strip of suture material

JOHN T BATE, M D,  
*Louisville, Ky*

## BOOK REVIEW

GYNCOLOGICAL RONTGENOLOGY By JULIUS JARCHO, M D Quarto, cloth, 571 pages, 273 illustrations Paul B Hoeber, New York, 1931

THE present volume is the thirteenth of the series of monographic atlases being edited by James T Case, and represents the crystallization of many years' experience of the author in this department of diagnosis. Following the consideration of the general topographical anatomy of the female internal genitalia, the use of general rontgenological methods employed in gynecology and an historical review of the various means of rontgenological visualization of the uterus and tubes, the detailed description of perabdominal and per-uterine methods of inducing pneumoperitoneum are considered with their comparative usefulness, indications and dangers in administration. Therapeutically, the most notable use of this method is in the treatment of tuberculous peritonitis with intraperitoneal inflation with oxygen, the most striking being the results recorded by H B McCorkle. Certainly from a consideration of these, this method deserves a very essential and predominant place in the treatment of this condition.

The element of error in the diagnostic interpretation by this procedure is, however, very great and has been properly replaced in a large degree by uterosalpingography induced by the instillation of iodized oil into the uterine cavity as developed notably by Rubin. The combination of these two methods has in many instances distinct advantages which would not be possessed by using either one alone.

All of the various pathologic conditions found in the uterus and adnexa are considered and radiographs introduced depicting the findings. The question of female sterility naturally is given a predominant consideration. Ectopic pregnancy, flexions, versions, fibromata and inflammatory conditions are adequately and instructively presented.

The book is concluded by a chapter on radiation therapy in gynecology. The fifty pages devoted to this subject might possibly have better been omitted. Its relation to rontgenology and inclusion in the text of the already oversized volume is questionable. Its subject matter, however, is of very practical importance and interest, and details the author's technic of radium therapy with dosage and methods of filtration. The reviewer feels, however, the subject would be better included in a gynecological treatise.

JAMES T PILCHER, M D



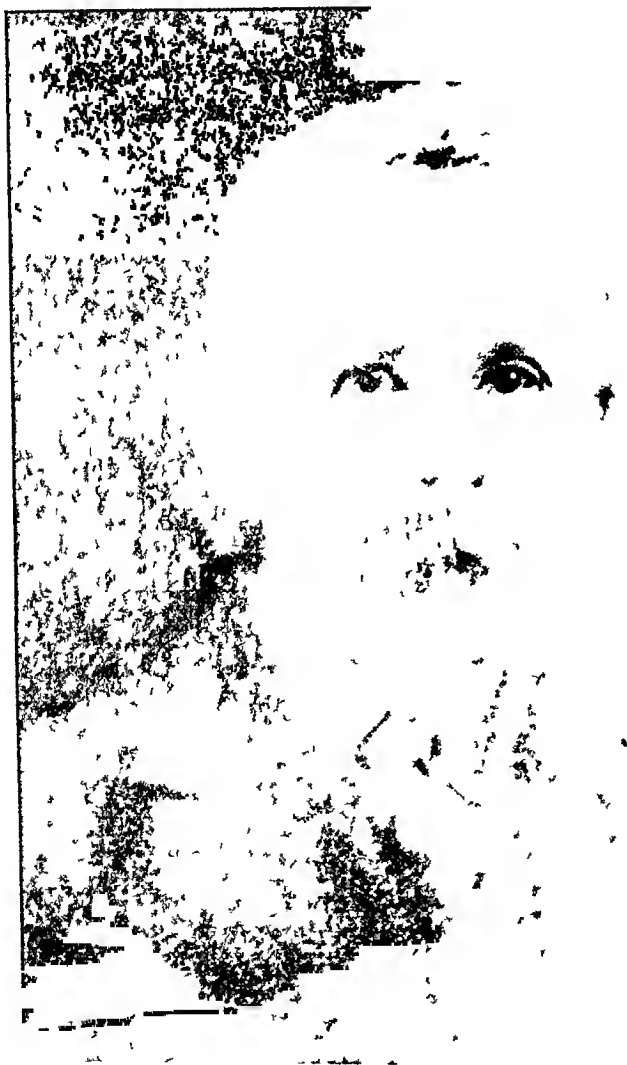
# MEMOIRS

## NORMAN BRUCE CARSON, M D

1844-1931

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ON THE morning of Monday August 29, 1931, Dr Norman Bruce Carson died Born in Somerset Pennsylvania, November 9 1844, he had



NORMAN BRUCE CARSON, M D

passed his eighty-sixth year when his summons came His last six months were a period of invalidism incident to his advanced age

Doctor Carson was brought to St Louis by his parents when he was three years old He secured his early and his later University training in that city, graduating from the Arts and Science Department of the newly founded

Washington University. He prided himself on the fact that he was present at the first graduating exercises held by that institution.

Graduated from St. Louis Medical College in 1868, he then spent a year of post-graduate study in Vienna, during the Franco-Prussian War period, after which he returned to St. Louis to take up the practice of medicine. In 1870, he was given a place on the staff of Mullanphy Hospital, where he continued to work as assistant, then as operating surgeon and finally as Chief of Staff, until his retirement from practice in 1920. His fifty-one years of active practice make one of the longest records credited to St. Louis practitioners.

He early became a member of the faculty of his Alma Mater, St. Louis Medical College, and when this institution merged with the Missouri Medical College, to form the medical department of Washington University, he became a member of the new faculty. He attained the rank of Professor of Surgery, and finally, resting from his teaching labors, in 1914 he was made Professor Emeritus. In 1925 Washington University conferred upon Doctor Carson the degree of D.Sc.

In 1888 he married Susan R. Glasgow, granddaughter of the first mayor of St. Louis.

He was a fellow of the American Surgical Association, serving as Vice President in 1903, fellow of the American Medical Association and of the International Surgical Association. He had held the positions of Vice President of the Missouri State Medical Association, President of the St. Louis Surgical Society, and President of the St. Louis Medical Library Association.

Such is the chronological sequence of the life of Norman Bruce Carson, but it does not frame the man. Indeed, it scarcely connotes the colorful individual driven, for over half a century, by the two powerful impulses of surgical fervor and love of the out-of-doors. The solitudes of the American Rockies and the Canadian forests and streams furnished him the necessary respites from the dynamic surgical energy which placed him among the first to apply the antiseptic method in the middle West, and the first in St. Louis to remove the Gasserian ganglion for trifacial neuralgia. He was also a western pioneer in surgery of the abdomen and of the central and peripheral nervous systems.

M. G. SEELIG

## CHARLES N DOWD, M D

1858-1931

To HAVE completed a useful life, respected and loved by his associates, a leader in his profession, a revered citizen was the achievement of Dr Charles N Dowd

Born in New Britain, Connecticut, April 29, 1858, Doctor Dowd passed his boyhood in Saratoga Springs, with which he was closely associated



CHARLES N DOWD, M D

throughout life. He was graduated from Williams College in 1879 and then taught in his father's school for two years, running the school as a hotel during the summers. His determination to study medicine persisted, though there were real obstacles—financial stress, his father's opposition, and, finally, an infection of the eye which made it necessary to do all his studying for some months by having the subjects read to him.

He received his medical degree from the College of Physicians and Surgeons, New York, in 1886. After an internship at Roosevelt Hospital, he practiced medicine successfully, being recommended by Dr. Francis Delafield to many families west of Central Park, where he developed a large practice. His interests, however, were always in surgery, with which he kept in touch by attending the New York Post-Graduate Medical School, first as a student and later as instructor in surgery.

Doctor Dowd gradually limited his activities to surgery and rapidly progressed in that field. He became Attending Surgeon to the General Memorial Hospital, a position which he held from 1894 to 1914. He was Attending Surgeon at St. Mary's Free Hospital for Children from 1905 to 1914, and at Roosevelt Hospital from 1914 to 1924. Later he became Consulting Surgeon to Roosevelt Hospital and St. Mary's Hospital in New York and the Saratoga Hospital. He was professor of clinical surgery at the College of Physicians and Surgeons. He received an honorary degree of Doctor of Science from Williams College in 1924. During the World War he was a Major in the Medical Corps, United States Army.

His connection with the General Memorial which treated a large number of cases of malignancy directed his early work toward this line. His early papers deal largely with this phase and he devised a plastic operation to cover the defect caused by the radical excision of epithelioma of the lip. At St. Mary's he had an opportunity to develop the surgery of infancy, and surgery of the neck was his great contribution from this service. Tuberculosis of the cervical lymph-nodes was a common disease of childhood at that time. It was poorly treated. He attacked this problem with characteristic thoroughness, studying etiology, operative procedure and late results. He demonstrated that surgical cure could be accomplished by a complete removal of the diseased nodes and devised incisions which would give the maximum exposure with the minimum of scarring. An important phase of the work was done in conjunction with Dr. William H. Park, which proved that the causative organism in the large percentage of the cases was the bacillus of bovine tuberculosis, and hence, that milk was a potent source of infection. In line with his neck surgery and also with a previous study of mesenteric cysts was his study of hygroma.

Doctor Dowd was a Fellow of the American College of Surgeons and of the American Surgical Association, a member of the New York Surgical Society, the New York Clinical Society, the Academy of Medicine, the American Medical Association and the West End Medical Society. He took an active and constructive part in the activities of these organizations.

Many of his contributions, which number over 130, will long exert influences on movements of the utmost importance, movements which he did not originate, but in which he was a pioneer.

He was an admirable executive, and was characterized by a methodical thoroughness and a meticulous attention to detail, and he expected the same of his subordinates. His opinions were formed always after mature deliberation. He had a most amiable and jovial disposition which brought him a

host of intimate friends. His associates had not only an admiration and respect for him but also a deep affection.

Although he discontinued the active practice of medicine and surgery while still in good health, he continued to work and during the last few years had been of valuable assistance to the Saratoga Hospital, in which he was interested as a member of the Board of Managers and Consulting Surgeon.

His active mind led him into many channels of work. He was one of the founders of the Lake Avenue Association, Saratoga, he wrote a book describing the struggle for recognition of standard time, of which his father was the inventor, he frequently wrote articles on hospital work for the *Saratogian* and only six or eight months before his death he evolved a transportation program for Saratoga Springs which was adopted by the planning commission and if followed out, will be of inestimable advantage. And so, in his retirement from the practice of his profession, he did not retire from work but led a busy, helpful life as he passed into the seventies.

After many years of distinguished medical and surgical service, Doctor Dowd died in Saratoga at the age of seventy-three on May 24, 1931. In his death the profession lost a leader, the community a good citizen, and those who were associated with him, a loyal friend.

#### EDITORIAL ADDRESS

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## THE CLINICAL SIGNIFICANCE AND APPLICATION OF HISTOLOGIC GRADING OF CANCERS

BY WILHELM C HUEPER, M D

OF PHILADELPHIA, PA

FROM THE CANCER RESEARCH OF THE GRADUATE SCHOOL OF MEDICINE OF THE UNIVERSITY OF PENNSYLVANIA

THE practicability, reliability and clinical significance of histologic grading of malignant tumors have been, in recent years, the subject of lively controversy among pathologists and clinicians engaged in the diagnosis and treatment of cancers. While numerous workers have adopted this method as a matter of routine and are using it extensively and successfully (Broders, Ewing, Hueper,<sup>3</sup> Martzloff, Greenough, Warren<sup>8</sup> and others) attaching to its results definite clinical significance, others have voiced scepticism in regard to its practical value (Wood<sup>6</sup>) or even condemn it as pure guess-work, being the product of a misconception and unreliable and even misleading in its results (Reimann<sup>7</sup>). As the danger exists that this discrepancy in the estimation of the merits of the method of grading is apt to cause confusion in the minds of those less familiar with this subject and with the issue at stake, and as the method of histologic grading may get into discredit through faulty technic and incorrect interpretation and application of the results obtained, as well as by unfounded criticism, it seems to be timely to present here a brief discussion of this subject.

I *The reliability of the method from a purely pathologic standpoint depends upon the following factors*—(1) The sections submitted for grading must originate from the peripheral, actively proliferating and therefore most characteristic portions of the tumor. Sections from ulcerated and infected parts, containing infections, nonspecific necroses and structural distortions of the tumor structure, are less suitable for this purpose, while sections from the central, degenerating parts of the tumor with secondary fibrosis and necrosis are often misrepresentative of the actual type of growth and therefore objectionable for grading.

(2) The sections must contain a sufficient amount of tumor tissue to allow a fair and intelligent evaluation of the histologic structure of the tumor. As the cancer diagnosis is not a single-cell problem, but based upon the interpretation of the general cellular structure and arrangement of the tumor parenchyma and its relation to the surrounding stroma, there is a lower limit to the size of the section from which a diagnosis can reliably be made. It is, however, advisable not to use too small a piece of tissue for grading, even if it may suffice for diagnostic purposes.

(3) The presence of artificial cellular distortions resulting from technical defects due to improper handling before fixation (drying, decomposition) or due to faulty preparation (fixation, dehydration) and staining, make sections unsuited for the method of histologic grading

(4) The pathologist or whoever acts in this capacity must be familiar with the histopathology of tumors and especially with this type of work. It requires special training before that degree of experience is acquired in the structural analysis of tumors which is necessary for the proper grouping of tumors into grades of malignancy

If any one of the above-mentioned basic requirements for the histologic grading of cancers is not fulfilled, the pathologist should not hesitate to refuse a request for a histologic malignancy determination, because results obtained without consideration of these factors are apt to be unreliable, and may thereby discredit a method which has its definite merits, if correctly performed and sensibly applied. Neglect of these technical rules is the cause of many of the discrepancies in the results obtained as reported by different authors. A good part of the criticism to which the method of histologic grading of cancers has been subjected in the past finds thereby a just and ready explanation

Another source to which much of the criticism of the method of histologic grading can be traced may be found in the fact that the purpose of grading has been misunderstood and the results obtained have been applied without discrimination in regard to the character of the case and without consideration of the natural limitations of the method and the information gained through it

The purpose of the histologic malignancy determination of cancers is an estimation of the potential proliferative qualities and metastatic tendencies of the neoplasm examined, through an evaluation of the degree of differentiation and amount of anaplasia presented by the tumor. The variations of these factors observed in the different cancers serve as the basis for their grouping into three or four grades of malignancy depending upon the technic employed by the different investigators. The histologically least malignant tumors receive grade 1. Cancers with histologic features indicating a higher degree of malignancy are graded accordingly into cancers of grade 2, 3 and 4. Consideration of the condition of the stroma is given only in the method of the histologic malignancy index as developed by Hueper. In all other methods, the interpretation of the histologic structure of the cancer is restricted to that of the parenchyma. An additional difference between the methods of this latter type and that of the histologic malignancy index is found in the technic of evaluation employed. While the investigators, following more or less closely Broder's lead, grade mainly on the basis of a general impression, that is, according to the percentage of the undifferentiated cells present in the tumor, Hueper's method is based on a numerical evaluation of twenty different histologic factors pertaining to the tumor parenchyma as well as to the stroma

Considering the fact that surgery as well as X-ray and radium therapy are mainly local means for the eradication of cancers and are only successfully used as long as these tumors are of a more or less localized character, the practical significance of histologic grading rests upon its proper clinical interpretation into terms of prognosis and type of therapy best suited for the individual case, as indicated from the histologic malignancy grade

II *Malignancy grade and selection of type of treatment*—Clinical experiences point to the fact that immature and highly anaplastic cancers are more successfully treated with X-rays and radium than by surgery, whilst mature and highly differentiated tumors with a low degree of anaplasia respond better to surgical treatment. The histologic grading of malignancy represents, therefore, the basis on which the decision as to the type of treatment best suited can be made by the clinician

It is a rather widely accepted dogma among cancer therapists that the marked proliferative activity observed in the highly malignant tumors is the main cause for their good response to irradiation, whilst the small number of mitoses usually seen in highly differentiated and therefore less malignant cancers makes them less susceptible or even refractory to X-rays and radium. It is not denied that cells in the state of mitosis are radiosensitive, but recent experiments of Mottram<sup>9</sup> and Fischer<sup>10</sup> indicate that there are apparently active additional factors which influence radiosensitivity. Fischer asserts, from his observations on tissue cultures, irradiated with mesothorium, that the quantitative effect of irradiation on slowly and rapidly growing cultures is proportionally the same. Mottram, on the other hand, emphasizes the importance of the environmental factors on the "radiosensitivity" of the tumor

But beside these more or less cellular aspects of irradiation effects, two factors exist in the vital qualities of highly malignant tumors which make them more suited for irradiation therapy. The one factor is the more diffuse infiltrative local growth of cancer cells of highly malignant tumors which makes their surgical eradication difficult and is the cause of subsequent local and distant recurrences after this procedure. The homogeneous penetration of the involved area by X-rays or radium rays guarantees the effect of the therapeutic agent on all tumor cells present in the irradiated region. The second factor is the great tendency of immature tumors to produce metastases at a time when the primary neoplasm is still relatively small. Also, here, irradiation of the regions of the lymphatic drainage will more effectively attack, for purely physical reasons, the scattered malignant cells than surgery can hope to accomplish

While therefore an improvement in the curative results in highly malignant tumors by the use of rays can be expected and is observed, it seems to be very unlikely that irradiation treatment should transform in a paradoxical manner these otherwise highly dangerous tumors into new growths offering the best curative prospects. Carcinomas of the uterine cervix do not represent an exception, as the generally held conception that these



cancers rarely extend beyond the upper rim of the pelvis, and remain therefore more or less local allowing the application of a sufficient amount of irradiation, is not correct according to the investigations of Maljeff<sup>4</sup> and Ford,<sup>11</sup> and, quite recently, of Warren<sup>8</sup>. The latter author, who studied the metastatic spread of seventy-four cases of cervical cancer at autopsy and compared his findings with the grades of malignancy, found the following correlations

Visceral metastases were present in 35 per cent of the cases, they were distributed on the different grades as follows

	Cases	Per Cent Not Extending Beyond the Upper Pelvic Rim
Grade I	21	86
Grade II	34	44
Grade III	11	0
Adeno acanthoma	4	0
Adeno carcinoma	4	0

Considering these findings and the more or less local effects of irradiation therapy, the remarkable curative results of Healy,<sup>2</sup> who obtained ten times as many cures in "advanced" highly malignant cervical cancers (group III) as in "advanced" low malignant cancers (group I), that is, 42 per cent in group III against 4 per cent in group I, require certainly an explanation which cannot be based on differences in radiosensitivity of these groups. Variations in radiosensitivity may change in degree, but not in substance, the rule being that the higher the grade of malignancy, the worse the prognosis.

While the grade of histologic malignancy is helpful in the selection of the most suited type of treatment, it should not influence the extent and the intensity of the treatment. Any cancer, regardless of its grade, must be attacked with all available means and to the limit of the therapeutic possibilities.

*III Malignancy grade and prognosis*—The grading of cancers is at present always a group grading and not a grading of the individual case. The grade places the tumor in a group of tumors which have according to empirical observation a certain percentage of cures. As cures, with our present therapeutic means mainly depend on the absence of metastases, the histologic grade of malignancy expresses also the tendency of the tumor to form metastases. A high degree of histologic malignancy represents, therefore an indication for a less favorable prognosis than that present in a case with a low-grade malignancy if all other factors are equal. A case with a high-grade malignancy should, therefore, be especially carefully examined for distant metastases and should be frequently watched after operation or irradiation for the manifestation of such formations using all available methods for early detection (X-ray pictures, sedimentation tests, pH determination of the blood, etc.)

It should be moreover, kept in mind by the clinician that the histologic grade is only one of several factors which determine the prognosis of a

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cancer patient, and that a relatively reliable prognostication can be obtained only if the significance of these various factors is properly gauged

If the effect of a correct or incorrect treatment on the outcome of the disease be disregarded, the extent and the location of the cancer are the most important factors which determine the ultimate result. The clinical grouping of cancers as done by Schmitz and others have shown in a clear and convincing way the prognostic value of the first-mentioned factor. The combined effect and prognostic interrelation of extent and grade have been demonstrated by Hueper through an evaluation of 117 cancers of the breast and uterine cervix in regard to extent and malignancy index

	Clinical Groups		
	I	II	III
32-44	100	100	86
45-56	100	70	53
57-68	60	45	27

3 years' good end-results in percentages

An indirect relation exists between the prognostic significance of the malignancy grade and the extent. The prognostic value of the grade decreases with the increase in the extent of the tumor. The determination of the grade is, therefore, without any practical value as far as prognosis is concerned in generalized cancers. This statement in connection with several others made above illuminates also the scientific value of investigations in which it was attempted to determine the merits of the methods of grading by grading sections of breast cancers taken at random without consideration of the source of the section, extent of disease, *etc*, and expressing the grade in terms of life expectancy of the individual case (one, two and three years). Such attempts are, indeed, pure guess-work and doomed to failure.

The second important clinical factor which has to be considered in any prognostication is the location of the tumor. The well-known variations in the curative results obtained in cancer of the cervix uteri and corpus uteri as well as of the cancers located at the base of the urinary bladder and at the dome of this organ may illustrate the importance of this factor.

There exist many other factors which have a bearing upon the prognosis, which are, however, less well known in their mechanism and effect and can therefore less definitely be evaluated (gross type of tumor, heredity, etiology, general status of patient, *etc*). I may mention in this connection only one more factor which was recently discussed and investigated by McDonald and associates—it is the pH of the blood. McDonald found that untreated cancers with an alkaline pH of the blood show a shorter life expectancy than those with a normal or relatively acid pH. In subsequent correlative studies of Hueper it was demonstrated that cancers with an alkaline pH of the patient's blood are predominantly of an immature type, a factor which may account for the differences in longevity observed by McDonald. These observations bear out, also, the statement of Flothow<sup>1</sup> that the degree of differentiation of a tumor is a function of its environment.

CONCLUSIONS

(1) Sections removed for grading must be taken from the peripheral zone of the tumor, must be properly prepared and stained and evaluated by a pathologist familiar with the method of grading

(2) Grading is helpful in the selection of the type of treatment best suited in the individual case

(3) The malignancy grade must never interfere with the extent or intensity of treatment

(4) The malignancy grade indicates the proliferative and metastatic tendencies of a cancer

(5) A reliable prognostication of a cancer must include at least three factors The malignancy grade, the extent, and the location of the tumor

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# A BACTERIOLOGICAL STUDY OF CHRONIC ULCERATION IN RELATION TO CARCINOMA \*

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THIS study involves a clinical, bacteriological and serological correlation of forty-one identical strains of streptococci isolated by anaerobic tissue cultures from twenty-four resected ulcers of the stomach, five of which were carcinoma, two were from ulcerative colitis with large adenomatoid hyperplastic polyps, two were from carcinoma of the rectum, eight from the cervix, and three from carcinomata of the breast

All these organisms are proved identical by agglutination, cross agglutination and agglutinin absorption, and in turn they are proved identical morphologically and culturally with the streptococcus lacticus which may be consistently isolated from cows' milk Because of these facts a correlation might be made of the following disease groups gastric and duodenal ulcer, ulcerative colitis, infectious granuloma and polyposis of the intestine, chronic cervicitis and Hodgkin's disease and carcinomata

Microbic dissociation is the determining and all-important factor in this correlation Without going into a detailed description of the dissociation of this streptococcus, may it be said that on initial culture, bits of tissue seeded in the depths of  $\frac{1}{2}$  per cent semi-solid hormone agar, it appears as a fine filament and small coccus After repeated transplants and gaining the ability to grow aerobically, it varies morphologically from a diphtheroid-like rod, solid-staining rod and beaded rod to a short and long chained lanceolate coccus These morphological changes of the individual organism occur as the colony type changes from S—R

The life cycle may be said to parallel, therefore, that of the mycobacterium group which Kahn has recently demonstrated, and has morphological similarities to the *mycobacterium Phlei* and the *mycobacterium granum* found in plant dust and cultivated soil and the *mycobacterium steircussis* found in dejecta of cows The market butter *mycobacterium rubi operitinctum* and *Fribm gense* may have had the same origin The infectious granuloma type of disease of the intestinal tract of cows is due to the same type of organism, the *mycobacterium para-tuberculosis*

This supposition is strongly substantiated when one observes the many

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\* Read before the Section of Surgery of the New York Academy of Medicine, October 2, 1931

TABLE  
*Cultural and Serological Relationship of 111 Strains*

Culture	Source	If emolysing of blood	Agglutination with sera 2 and 66 titre 2 1-12800 66 1-6400	Agglutination after absorp- tion with sera 2 and 66	Fermenta- tion reaction esculin bile	Sodium thio- sulphate media —degree of blackening by sulphur production	Acidity figure change of 1% glucose broth from 7.4 to	Mannite fermenti- tion	Heat resistance growth on 1% lactose agar after heating at 63° for 45'	Lactose fer- mentation in 24 hours
2	Gastric ulcer	A	1-12800	0	+	++	4.4	+	+	+
9	Dog ulcer	A	1-6400	0	+	++	4.4	+	+	+
19	Gastric ulcer	A'	1-12800	0	+	+	4.5	+	+	+
20	Gastric ulcer	A'	1-12800	0	+	+	4.6	+	+	+
23	Gastric ulcer	A	1-12800	0	+	++	4.4	+	+	+
45	Gastric cancer	A'	1-12800	0	+	+	4.3	+	+	+
46	Duodenal ulcer	A	1-12800	0	+	+	4.3	+	+	+
47	Gastric ulcer	A	1-12800	0	—	+	4.5	—	+	—
53	Gastric ulcer	A'	1-12800	0	+	+	4.6	—	+	+
55	Gastrojejunal ulcer	A	1-12800	0	+	+	4.5	+	+	+
56	Gastrojejunal ulcer	A	1-12800	0	+	++	4.6	+	+	+
58	Gastric ulcer	A'	1-6400	0	+	++	4.3	+	+	+
59	Gastric cancer	A'	1-12800	0	+	+	4.6	+	—	+
60	Gastric cancer	A'	1-12800	Trace 1-100	+	++	4.6	+	—	+
61	Gastric ulcer	A'	1-6400	0	+	+++	4.3	+	+	+
62	Gastric ulcer	A'	1-12800	0	+	++	4.4	+	+	+
63	Gastric ulcer	A'	1-6400	0	+	++	4.4	+	+	+
64	Duodenal ulcer	A'	1-6400	0	+	+++	4.4	+	+	+
66	Gastric cancer	A'	1-6400	0	+	+++	4.4	+	+	+
67	Duodenal ulcer	A'	1-6400	Trace 1-100	+	+++	4.4	+	+	+

# ULCER BACTERIA AND CARCINOMA

68	Gastric ulcer	A'	I-6400	Trace 1-100	+	++	44	-	+	+
74	Gastric ulcer	A	I-3200	0	-	+	44	-	-	-
79	Gastric cancer	A	I-3200	0	-	+	43	+	+	-
79B	Blood-stream gastric cancer	B	I-3200	Trace 1-100	+	+	44	+	+	+
83S	Gastric ulcer	A	I-3200	Trace 1-100	+	+	45	-	-	-
83R	Gastric ulcer	A	I-3200	Trace 1-100	+	+++	44	+	+	+
69	Breast cancer	A	I-3200	0	+	++	45	+	-	+
70	Breast cancer	A	I-3200	0	+	++	42	+	+	+
73	Breast cancer	A	I-3200	0	+	++	46	+	+	+
81	Rectal cancer	B	I-6400	0	+	+++	48	+	+	+
82	Rectal cancer	B	I-3200	0	+	+++	46	-	+	+
84	Ulcerative colitis	A'	I-6400	Trace 1-100	+	++	44	+	+	+
85	Ulcerative colitis	A'	I-6400	0	+	+++	44	+	+	+
225	Cervix	A'	I-3200	Trace 1-100	-	++	46	-	+	-
226	Cervix	A'	I-3200	0	+	+++	42	+	+	+
253	Tissue uterus	A'	I-3200	0	+	+	47	+	+	+
255	Tissue uterus	A'	I-6400	0	+	+	47	+	+	+
263	Tissue uterus	A'	I-3200	Trace 1-100	-	++	47	-	-	-
266	Uterine swab	A'	I-6400	0	-	++	46	+	+	+
273	Cervix	A'	I-3200	0	+	+++	46	+	+	+
274	Uterus	A'	I-3200	0	+	+++	43	+	+	+
90	Cows' milk	A'			+	+++	44	+	+	+

NOTE.—(1) Strains 63 and 67 lost before cultural work completed, (2) titre figure is end-point of agglutination, (3) cultures 2 through 58—agglutination against serum 2, cultures 59 through 274—agglutination against serum 66, (4) culture 90 too recent to homogenize for agglutination and absorption

morphological stages in its life cycle, which may be brought out *in vitro* by environmental changes

*Gastric and Duodenal Ulcer* —Whether one believes or not that the isolation of an identical organism from twenty-four resected ulcers proves it to be the etiological factor, the fact of its being there constantly and not a casual finding cannot be denied. And it is the constant finding of every bacteriological investigation of this disease

The only other method of experimental approach warranting consideration that of surgical duodenal drainage, has proved much less constant. Only one out of seven identical surgical duodenal drainage operations, performed by senior students, resulted in the production of an ulcer. This would suggest, then, another factor besides the loss of alkaline duodenal contents. Other investigators have had a higher percentage of positive results

The organism has been shown to produce ulcers in the dogs' skin when injected intradermally, has been demonstrated in immediately fixed levaditi-stained sections of ulcers in great numbers, and its inability to grow in media containing bile of extremely low dilutions assured

Patients suffering from gastric ulcer have this organism's specific agglutinins in their blood serum in 100 per cent. of cases tested, while those suffering from any other type of streptococcus infection fail to agglutinate or only in low titre

In one case the organism isolated by tissue culture from a carcinomatous gland of the stomach was proved identical serologically with the organism isolated from the blood-stream, when bacteraemia occurred on the eighth post-operative day

*Ulcerative Colitis and Carcinoma of the Rectum* —The same streptococcus has been isolated from two positive carcinomata of the upper rectum and from two extreme cases of ulcerative colitis with carcinomatous-appearing constrictions and diffuse adenomatoid hyperplastic polyps of the upper rectum. On biopsy, however, a positive diagnosis of carcinomata could not be made. The bits of tissue in each case were cauterized and placed in formalin for a short while to prevent contamination with the entire intestinal flora. When contaminants were present, they were easily obviated by cracking the tube and recovering the growth in the depths of the semi-solid media

It is well established that the Beta type of streptococcus rarely occurs in the colonic flora and the Alpha type is relatively infrequent when there is no evidence of disease. In a large series of patients suffering from complete anacidity of the stomach, Torrey rarely found these types in the stool specimen. The occasional surviving salivary type found in the intestinal flora is readily differentiated by its cultural and morphological characteristics

The bowel streptococcus described by Dible is culturally identical with this organism in all of its major characteristics except that of hæmolysis, which he believes does not occur. Hæmolysis is indicative of increased virulence and when isolated from active pathological processes they are hæmolytic. Their hæmolytic activity is gradually lost on artificial cultivation

The diplococcus isolated by Barger from ulcerative colitis is morphologically and culturally identical with this type. Ayres and Johnson found their enterococci indistinguishable in their major characteristics from typical lactic-acid cocci of milk, and they, with Dible, conclude that they are either closely related or identical.

The infective granuloma, chronic tumor-like productive inflammation of the gastro-intestinal tract, so ably reviewed by Mock, are identical pathologically with the adenomatoid hyperplastic polyps of advanced ulcerative colitis.

Fitzgibbon and Rankin, in their review of polyposis of the colon, found that carcinomata of the large bowel could be traced back through unbroken lines to polyps. They believe that the genealogical evidence for these growths, and that to be found in the literature for other similar carcinomata, argue persuasively for the extremely plausible contention that the histogenesis of carcinoma of the colon is mediated through pre-cancerous polyp formations and not otherwise.

Verse has described the earliest carcinomata of the stomach found in routine post-mortem examinations, and in each case the origin was on an acute inflammatory base with polymorphonuclear infiltration. This evidence would then seem a much better criteria of carcinomatous origin than the pathological study of full-grown carcinoma.

Cooke has reviewed the literature of carcinoid tumors of the small intestine and found reports of twenty-one malignant and eighty-three benign such tumors, the greatest proportion occurring in the distal ileum.

*Hodgkin's Disease*—Singer has lately reported a case of primary isolated lymphogranulomatosis of the stomach and was able to find only six other reports in the literature. David later reported another, which, although microscopically lymphogranulomatosis, he called a pseudo-carcinoma of the stomach. The patient died later following development of a rectal mass which was presumably Hodgkin's infiltration.

To these eight cases may be added two from the Second Surgical Service of Bellevue Hospital. One, a man aged forty-five years, was operated upon by Doctor Hartwell in 1920 for gastric ulcer. The ulcer was locally excised. Dr. James Ewing pronounced it histologically typical to Hodgkin's disease but felt a malignancy could not be ruled out. The patient died twenty-two months following operation from a progressive cachexia and inability to eat.

The other case, culture 85 in this series, presented a mass in the upper rectum and sigmoid felt at operation to be a carcinoma. Proctoscopy had shown a diffuse ulcerating mucosa and a biopsy specimen for culture and diagnosis was taken. Dr. Douglas Symmers said it was histologically Hodgkin's disease.

The best experimental work on Hodgkin's disease may be correlative and not conflicting. Bunting and Yates cultured a pleomorphic diphtheroid from Hodgkin's gland and claimed to be able to produce a similar disease in monkeys by its injection. Torrey, in 1918, found anaerobic diphtheroids frequently in Hodgkin's gland, which he termed the *bacillus lymphophilus*, but also isolated it from other types of abnormal glands, and, therefore, did not feel it was the etiological factor.



L. Espérance inoculated chickens intravenously with emulsions of Hodgkin's nodes and they all developed typical or atypical tuberculosis, and tissue smears showed acid-fast and non-acid-fast granules and rods. Growth of bacteria from these lesions showed the staining and cultural characteristics of an Avian tubercle bacillus.

Chretien, Germain, and Raymond showed that Avian tuberculosis manifests itself in a variety of forms but attacks principally the spleen and lymphoid apparatus, with a characteristic immunity of lungs. They classify two forms: the nodular and neoplastic types—the first granulomatous in character, the second showing an active proliferation of large polyhedral cells exhibiting a tendency to infiltrate surrounding structures. It exhibits many of the features of a neoplasm. What could more logically be the source of infection in birds than the dejecta of cows and horses and the fertilized soil? It is highly probable that this organism is one and the same in different stages in its life cycle and isolated as a granule, rod, bacillus or coccus, due to the environment in which it has been growing.

*Cervix Uteri*—Eight cultures, kindly given to us by Dr. William Park, were isolated from the cervix uteri during post-mortem infection and puerperal sepsis. The intestinal streptococcus is by far the most frequent infecting organism of the female genital organs, especially chronic endocervicitis. It may be considered a normal inhabitant of the vaginal vault and has been found in 70 per cent of a series of cases examined. (Dible.)

Maryan has recently completed a study of tissue cultures from chronic cervicitis and was able to grow a streptococcus which biologically and morphologically was identical for forty-one of fifty-one cases of trachelectomy specimens. This organism confirmed morphologically and culturally to the enterococcus type of Dible.

A most exhaustive study of the pathological changes noted in 850 cervical specimens has been made by Bailey. He has outlined most carefully the individual developments occurring in acute cervicitis and chronic endocervicitis. He has followed the notable changes in the squamous and columnar epithelium, due to continued irritation of the infecting agent by serial sections, and has determined the resultant effect upon the new highly sensitive basal cells that cannot withstand the effects of constant irritation in any amount without proliferative activity and carcinomatous degeneration.

*Carcinoma of the Female Mammary Gland*—The identical streptococcus has been isolated from three carcinomata of the female mammary glands in the same manner. Controls of normal breast tissue away from the carcinomatous area gave sterile cultures, as did two fibromata removed from the breast.

The pleomorphism of this streptococcus type is best illustrated by culture 75 isolated from one of the above three cases. The growth did not appear from the tissue until the eighth day. On staining it showed fine filaments and many granules. On continued culture, gradually gaining the ability to grow

aerobically, it became a diphtheroid bacillus, a solid rod, a beaded rod and finally remained stable as a short, chained streptococcus

Nuzum isolated a micrococcus from thirty-eight of forty-one human breast carcinomata and from more than 100 mice bearing transplantable Crocker fund carcinoma No 11. By injecting these organisms into and under the skin of mice he obtained warts, epithelial horns and spreading cutaneous ulcers with localized epithelial hyperplasia.

Warren and Pearce repeated Nuzum's work both with his organism and with diphtheroid and micrococci cultures which they had isolated from human breast carcinomata. Inoculation into the breast of rabbits caused scarring and swelling of connective-tissue cells which resembled epithelioid cells in a tubercle. Hyperplasia of the duct epithelium and mitoses were noted. They also produced the chronic ulceration of the skin which Nuzum had done. They felt that these organisms did not play a primary rôle in the etiology of cancer though an indirect rôle, they felt, was possible.

It is doubtful whether such experimental attempts are a fair test of this theory. An animal's life is too short to permit in any way the reproduction of the conditions as they occur in man.

A vaccine and a filtrate of this organism were made for a skin sensitivity test. Three patients suffering from inoperable carcinoma of the breast showed a definite large wheal lasting twenty-four hours to an intradermal inoculation of the vaccine. Six patients suffering from breast abscesses (all nursing mothers) showed no reaction. The pyogenic breast abscesses, therefore, probably have no influence on breast carcinomata.

Lee states that the rapidly growing carcinoma of the breast in the young simulates an infectious process. He has reported thirty-eight cases which he classifies as inflammatory carcinoma.

*Discussion*—In a previous article the metabolism of this streptococcus was cited in comparison with the metabolism of the carcinoma cell as brought out by Otto Warburg. Both are anaerobes and both by glycolysis produce lactic acid. He has shown that lactic acid is necessary for the growth and spread of carcinoma cells.

Hammett concludes, "that the  $-SH$ , incompletely oxidized— $SH$  groups, comprise the chemical elements of the naturally occurring chemical equilibrium through which growth by increase in cell number is regulated. He has shown that at a pH 5.5, where the sulphur is in the reduced state, stimulation occurs, and at a pH 7.2, where it is in the suboxidized state, retardation takes place, and that between a pH 6 and 7, where equilibrium exists between the reduced and suboxidized sulphur, no consistent direction of response is registered.

As a result of this work, Reimann prepared an  $-SH$  compound (thio-cresol) and both in experimental wounds and in human stubborn ulcers found that it stimulated mitosis and wound healing.

Cysteine and glutathione, compounds active in the oxidation and reduction processes of the body and present both in the circulating blood and other body tissues, are characterized by the  $-SH$  or sulph-hydral group.

With the foregoing facts in mind, an understanding of microbial dissociation and a glance at the table showing lactic-acid and sulphur production by the organism which coupled with its mannite fermentation and tremendous heat resistance differentiates it from all other streptococci and proves its identical relationship with the *streptococcus lacticus* of cows' milk, the following hypothesis can be formulated

That the chronic ulcerative lesion of years' duration which has finally started to show proliferative activity and uncontrolled cell division may be due to the following factors

(1) Continuous repair, (2) poor blood supply and lymph return, (3) the presence of the streptococcus described, which is characterized by (a) remarkable vitality (heat resistance above that of pasteurization), (b) lactic-acid production reducing pH of tissue to 4.2 to 4.8, which keeps sulphur in stimulatory phase, (c) hydrogen-sulphide production, (d) anaerobians

As a result of these four major characteristics, there is brought about a hydrogen-ion concentration and an oxidation and reduction potential in which the sulph-hydral group, present in all tissues in the form of cysteine and glutathione, is stimulatory to cell division

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# A STUDY OF THE RESULTS OF OPERATIONS FOR THE CURE OF CANCER OF THE BREAST

PERFORMED AT THE JOHNS HOPKINS HOSPITAL FROM 1889 TO 1931\* †  
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SINCE 1894, when Doctor Halsted first reported "Results of Operations for the Cure of Cancer of the Breast," performed on fifty consecutive patients at the Johns Hopkins Hospital, embracing a period from 1889, the year when the hospital was opened, there were published by him from time to time further studies of these, and additional cases which were treated at the hospital in the succeeding years. The first report of these studies was made in 1894, to be followed by others in 1898, 1907 and 1912. It therefore seemed fitting to us that the results of a further study, which includes not only later observations of the cases previously reported by Doctor Halsted, but as well those which have been treated at the Johns Hopkins Hospital since 1912, should be reported. This present study embraces a period of forty-two years, from 1889 to 1931, and includes a series of 950 consecutive cases. As would be expected and as was predicted by Doctor Halsted in the earlier reports, the estimation of the results of treatment from a statistical point of view must be constantly revised, at least until a sufficient number of years have elapsed after operation for a numerically representative group of patients to have died of carcinoma or other diseases, or to have completed their normal life expectancy—in other words, until there has accumulated a series of patients of sufficient number who have died over a period of years sufficiently long after their operation to have been afforded the opportunity of completing their normal span of life. It is to be expected that even so there will be marked and unavoidable fluctuations in the estimation of the results because of the unknown factors involved in the disease, and the individual variations of the patients.

Of the 950 patients considered in the study 420 (44.2 per cent) are known to have died, and accurate data pertaining to their post-operative length of life as well as other points of interest could be obtained. It would therefore seem that the period of years of observation, namely, forty-two, together with the size of this entire group of 950, of which the known dead comprise 420 (almost 50 per cent), would supply a sufficient length of time and number of patients from which at least fairly general conclusions may be drawn. Those patients who have been lost track of should be considered dead but of course it is always possible that some of them, probably only a small number may be found to be alive. In the present series this group numbered 209 (22 per cent). Ninety-seven patients (10 per cent) are alive.

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and well, and sixty-five (67 per cent) of these have lived more than five years. It is again probable that over a period of forty-two years patients may succumb to diseases other than carcinoma. As will be pointed out later under the cause of death, a large percentage of patients apparently *died with, if not of, carcinoma*.

It is evident that the angles of approach from which our series may be studied are many. It is equally apparent that a relation of statistics would be uninteresting and prohibitive reading. We have therefore felt that a discussion of the main points of interest under a few separate headings would tend to increase the readability and decrease the confusion which must accompany a profusion of tables and figures. However, it is also felt that the statistical results of this analysis of these 950 cases should be recorded in detail, so that in the future they might be available for further study or comparison. For this reason all the tables and graphs are shown with their detailed descriptions given in the legends.

Attention is directed to the fact that we are appreciative of the presence of an inescapable error in our statistics, and therefore realize that our conclusions are in all probability incorrect to some extent, because further data obtained in regard to the patients who remain alive, or of the relatively large group which have been lost track of for the present, may alter these figures considerably. This point may be illustrated by the fact that in the first fifty cases reported by Halsted in 1894 there were three (6 per cent) local recurrences. The second report in 1898 showed 9 per cent of local recurrences, and of this original fifty cases, from which three have been removed as not being carcinoma, leaving forty-seven, we can now, in 1931, trace fifteen local recurrences or an increase in percentage of local recurrences from 6 to 31.9 per cent. We feel, however, that the size of this entire group (950 cases), especially that of the known dead (420 cases), together with the length of the period of observation, forty-two years, insures a certain stability to the statistical averages, and while there may be some changes in the future, we feel that they will be inconsequential.

It is, of course, possible for surgical statistics to be improved by the selection for operation of only those cases which were favorable, and again, operations that have been performed on cases in which the disease was very extensive may have been classified as incomplete. In order to determine, however, the true worth of an operative procedure for the cure of carcinoma, not only the favorable but also the extensive or unfavorable cases should be included. It is, of course, realized that the converse is also true—namely, that the efficacy of an operation cannot be judged if an attempt is made to treat cases in which the limits of operability have already been exceeded previous to the operation. The fact that in this series of 950 cases over a period of forty-two years, only seventy-two (7.6 per cent) were untreated because the lesion was thought to be inoperable, eliminates any possibility of a selection of cases having been made. It is also to be noted that in the early days of the hospital before 1910 the disease was as a rule more extensive on admission and the limits of operability were considered wider than at present. It is, therefore,

felt that this series of cases constitutes a test for the operative treatment of carcinoma of the breast as severe as is possible with our present clinical methods and that the results in the future should with the same surgical technic and enthusiasm be better than in the past. Not infrequently at private clinics it is possible for certain individual operators, who devote themselves to one special operation or group of selected cases, to obtain results which are better than those to be expected from the average competent surgeon. Again, in this series of 950 cases 750 were operated upon in the Johns Hopkins Hospital by thirty-eight operators, eight of whom had never performed the operation before. Of the thirty-eight, thirty-one were either serving as Residents or had just completed a residency, so that the results of this series represent what may be expected from the application of a radical and meticulous surgical procedure in the treatment of carcinoma of the breast by a varied group of surgeons whose enthusiasm more often caused them to attempt to effect a cure of a hopeless case rather than a selection of favorable ones. In order to prevent or remove an ulcerated area but with no idea of curing the patient an incomplete operation was performed in only twenty-one cases or 2.2 per cent. Again, surgical statistics may be very much improved by the pathologist on whom the surgeon relies if he classifies as carcinoma, tumors in which the histological appearance is suggestive of malignancy in certain areas or is made up of malignant-appearing cells. This entire group of 950 cases have been examined from a pathological standpoint most thoroughly by pathologists who were entirely disinterested, *i.e.*, by Doctors Welch, Bloodgood, MacCallum, and their assistants. Recently these specimens were re-examined by Doctor Bloodgood.

The keen interest manifested by Doctor Halsted in the subject of perfecting a radical operation for the cure of carcinoma of the breast stimulated the remaining and succeeding members of the upper and residential surgical staff to perform the most meticulous type of dissecting operation, and in spite of the fact that the majority of the patients treated were public-ward cases with breast tumors that were classified as large and in which the disease was far advanced, the results from the standpoint of post-operative longevity and local recurrence, so far as we can discover, are unequalled. A number of years hence these remote results should be even better, for the affected breast is now operated upon at a very much earlier stage of the disease, and while the tumor is small. In these cases the operation should be, if possible, even more radical than in the cases of the larger tumors, for the opportunity to cure them is even greater. These points are emphasized because of the present-day tendency to withdraw somewhat from the stand of radical excision in favor of a less radical operation supplemented by the very questionable effect of radiation.

In order to determine the efficacy of the surgical treatment of carcinoma of the breast there are many important factors and influences which must be taken into consideration, such as the age of the individual and the activity of the gland, the type of tumor, the extent of the disease, the duration and size

TABLE I.—Frequency Distribution of Patients with Carcinoma of the Breast, by the Year of Incidence, Also a Classification of the Patients According to the Most Recent Reports

Johns Hopkins Hospital (1889-1931)

Years of incidence	Total No of cases	No of pts known dead	No of pts of whom track has been lost	No pts living and well	Doubtful carcinoma	No pts not treated	No pts having recurrence but not dead Prim oper J H H	No pts having recurrence Prim oper elsewhere	No pts having an incomplete oper	No of cases where there has been no follow-up	Carcinoma in situ-primary breast
1889	6	3									
1890	14	5		2		1			3		
1891	11	8	1						6		
1892	21	12	1		1	2		1	1		
1893	10	7	2			1		2	3		
1894	24	19	1	1	1	1			1		
1895	22	16			1	4		2			
1896	22	17		1	1	4		1	1		
1897	23	19	1			1		2			
1898	30	22		4			1	3			
1899	27	14	2	1		4		6			
1900	21	11	1	1		2		1			
1901	20	17	1					1			
1902	22	16	3			1		1			
1903	25	15	2	4		1	1	1			
1904	27	12	3	2		8			2		
1905	27	13	3	5		2	1	1	1		
1906	20	9	5	1		4		2			
1907	29	17	4	1	1	1	1	2			
1908	23	12	4	3		1	1	3			
1909	23	12	6	1	1	2		1			
1910	23	18	1			3		1			
1911	27	16	5	3		3		3			
1912	22	12		4		2	1	1			
1913	14	6	4	1		1		2			
1914	28	13	4	3		2	1	1			
1915	23	7	8	2		4		4			
1916	21	7	3	2		5		2			
1917	25	10	7	5	1	1		2			
1918	19	4	7	3		6		1			
1919	29	9	5	4	1	1	1	1	1		
1920	26	9	9	1	1			1			
1921	29	5	13	5		1	4	1			
1922	16	4	8	2		1	1	1			
1923	22	2	16	1		1	1	1			
1924	29	3	15	5	1	2	3	1			
1925	18	3	9	4		1		1			
1926	28	4	13	7			3	1			
1927	24	7	10	6				1			
1928	21	2	13	5	2	1		1			
1929	20	1	12	6			1	1			
1930	31	2	6	1				4			
1931	8					1			1	12	
Totals	950	420	209	97	11	72	24	77	21	18	1
Per cent	1 000	44 2	22 0	10 0	1 2	7 6	2 7	8 1	2 2	1 9	1

Year of incidence is equal to year of admission to hospital Of ninety-seven patients living and well sixty-five or sixty-seven per cent have lived more than five years



of the tumor, the type of operation, etc. These influences will be discussed in the following order under separate headings.

*Yearly and Age Incidence Together with Marital Status and Sex* — (Table I) The frequency distribution of the cases according to the year of their admission into the Johns Hopkins Hospital is considered the yearly incidence and varies only inconsiderably from 1889 until 1931. In this series, carcinoma

TABLE II — *Frequency Distribution of 950 Cases of Carcinoma of the Breast as to Marital Status Johns Hopkins Hospital (1889-1931)*

Marital status	No of patients, female	No of patients, male	Per cent of patients, female	Per cent of patients, male	Total no patients	Per cent of patients
Married	821	9	86.4	9	830	87.3
Single	118		12.4		118	12.4
Unknown	2		1		2	1
Totals	941	9	98.9	9	950	99.8

830 cases or 87.3 per cent married. 118 or 12.4 per cent unmarried. 9 or 0.9 per cent were males whereas 939 or 98.8 per cent were females.

TABLE III — *Frequency Distribution of 950 Cases of Carcinoma of the Breast as to Marital Status and Color Johns Hopkins Hospital (1889-1931)*

Marital status	White	Black	Per cent white	Per cent black	White males	Black males	Total no patients
Married	604	217	63.6	22.8	6	3	830
Single	98	20	10.3	20.1			118
Unknown	1	1	1	1			2
Per cent	74.0	25.1			6	3	
Total no patients	703	238			6	3	950

604 or 63.6 per cent were white and 217 or 22.8 per cent were black, while of those unmarried 98 or 10.3 per cent were white and 20 or 20.1 per cent were black. Of the males all were married. 6 or 0.6 per cent were white and 3 or 0.3 per cent were black.

of the breast has not occurred previous to the age of twenty or later than seventy-eight, but increases in the second and third decades of life to reach its maximum in the fourth decade, while the incidence subsides in the late seventies. This tendency occurs in the married and unmarried alike and is shown graphically in the curves A and B. It seems to be well ingrained in the surgical literature that married women are more frequently affected with carcinoma of the breast than unmarried. In Tables II and III may be seen the frequency distribution of these 950 cases as to the marital status, which would seem to support the above contention. However, when the marital status is tabulated in conjunction with the age incidence it is then possible to compare this group of 950 cases with an unaffected group of women of

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similar size in the United States distributed according to the 1920 Census, both in regard to marital status and age. In our series of 950 cases the age incidence and marital status were as shown in Table IV, while that of the

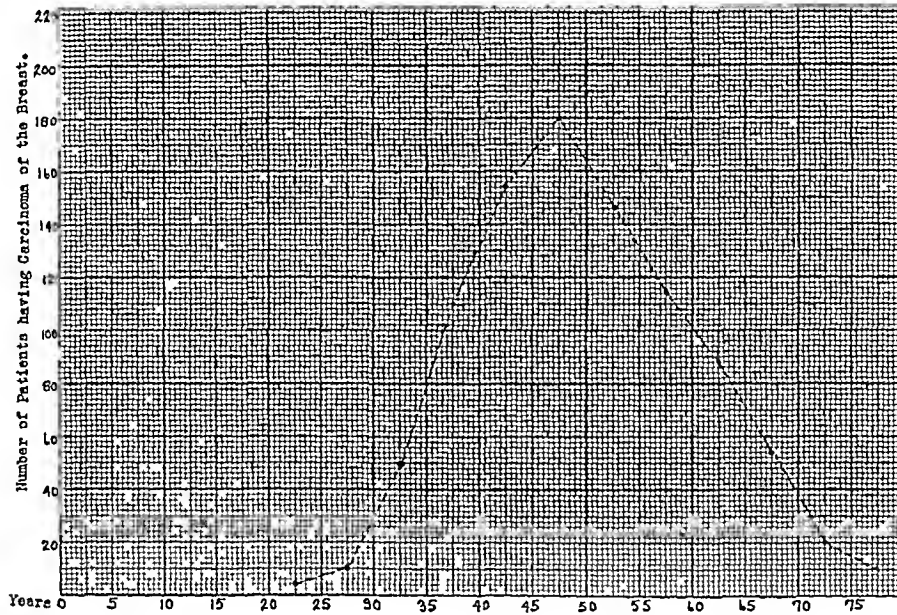


CHART A—Age incidence of carcinoma of the breast. Figures given in the total column, Table IV. Number of cases, 950.

unaffected group of 950 women according to the Fourteenth Census of the United States, 1920, vol. 11, is given in Table V. For the sake of comparison of the two groups of 950 women affected and unaffected, the age groups of

TABLE IV—Frequency Distribution of 950 Cases of Carcinoma of the Breast as to Age Incidence and Marital Status. Johns Hopkins Hospital (1889-1931)

Age in yrs	Married	Single	Per cent married	Per cent single	Status unknown	Total	Per cent
20-24	2	2	2	2		4	4
25-29	8	2	8	2		10	1.1
30-34	38	11	40	12		49	5.2
35-39	95	15	100	16		110	11.6
40-44	132	22	139	23		154	16.2
45-49	163	16	172	17	1	180	18.9
50-54	128	18	135	19		146	15.4
55-59	96	18	101	19		114	12.0
60-64	80	8	84	8		88	9.3
65-69	50	3	53	3	1	54	5.6
70-74	19	1	20	1		20	2.1
75 and over	8	2	8	2		10	1.1
Subtotals	819	118	862	124	2	939	98.9
Males	9		9			9	.9
Unknown	2		2			2	.2
Totals	830	118	873	124	2	950	100.0

Occurrence of carcinoma apparently increases through the second and third decades of life to reach a maximum in the fourth decade when the incidence subsides in the late seventies.

Table IV were changed from five to ten years, as shown in Table VI. Thus Tables V and VI corresponded. By taking the total number of women having carcinoma of the breast in each age group and applying to it the percentages given in the columns, married and single in Table V, the number of married and single women that would be in each age group, if they were not affected

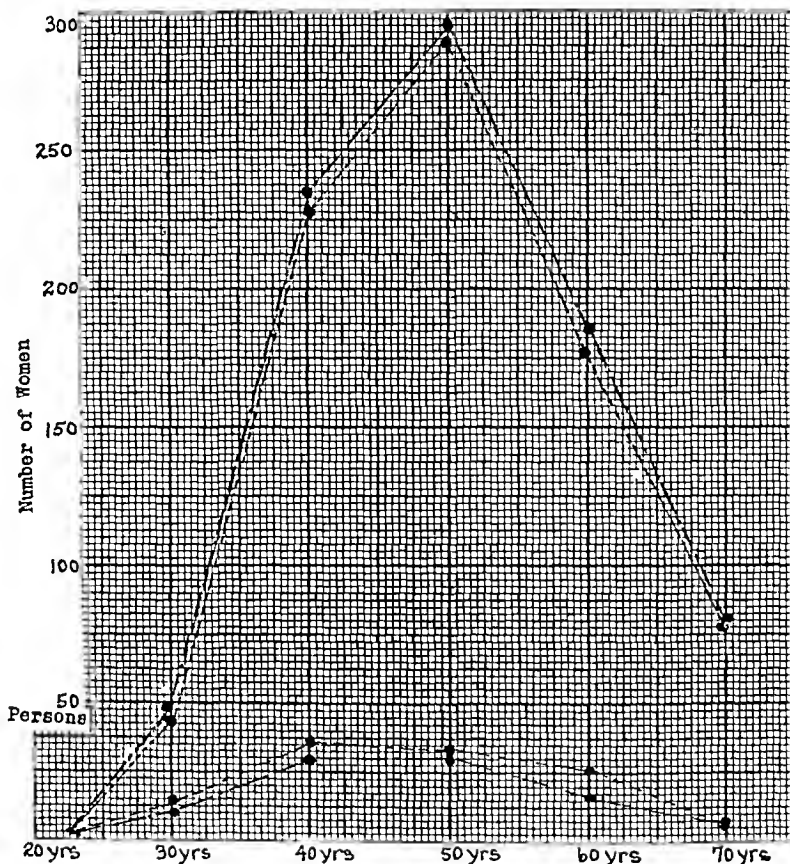


CHART B—Diagram showing that carcinoma of the breast makes no selection as to the marital status of women ———— Age distribution of 819 married women having carcinoma of the breast ———— Age distribution of 118 single women having carcinoma of the breast ———— Age distribution of 819 married women of the same age group (twenty to seventy five) according to the 1920 census, United States ———— Age distribution of 118 single women of the same age group (twenty to seventy five) according to the 1920 census, United States ———— Larger, upper group records married women, smaller, lower group records single women

by carcinoma of the breast, is determined. These figures are given in Table VII. By comparing Tables VI and VII it is seen that the number in each age group having carcinoma of the breast is almost identical with the group unaffected by it. Therefore, it is evident that the marital status played no part in the occurrence of carcinoma of the breast in this series of patients. This is graphically shown in Chart B.

As stated above, it is also apparent from Table III that white women are affected more frequently than colored, that this is only apparent is indicated by a study of the proportion of white and colored women in the United States as a whole, and Baltimore, Maryland, in particular. In the United States as a whole, there are 8.6 per cent colored and 91.4 per cent white women. This ratio is slightly higher in Baltimore, where there are 14.8 per cent colored

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TABLE V—*Marital Status and Age Distribution of All Classes of Females in the United States—1920\**

Age in yrs	Per cent single	Per cent married
All classes	50 7	49 3
Under 15	100 0	—
15 and over	27 3	72 5
15-19	87 0	12 9
20-24	45 6	54 3
25-34	19 3	80 6
35-44	11 4	88 6
45-54	9 6	90 3
55-64	8 4	91 5
65 and over	7 1	92 7
Age unknown	28 0	57 7

\* From Table V, Marital Condition of the Total Population by Sex and Age Periods for Principal Population Classes, for the United States, 1920, 1910, 1900 Pp 394-395 Fourteenth Census of the United States, 1920, vol 11, Population

Percentage of single women in the United States decreases in each ten-year period from fifteen years of age on, while the percentage of married or widowed women increases in each ten-year period from fifteen years of age

and 85 2 per cent white women, or a ratio of 1 576 or practically 1 6 (From the United States Census, vol 11, 1920 ) In this series of 950 cases the ratio of colored to white women is 25 per cent colored to 74 per cent

TABLE VI—*Frequency Distribution of 950 Cases of Carcinoma of the Breast as to Age Incidence and Marital Status (ten-year age groups)*

*Johns Hopkins Hospital (1889-1931)*

Age in yrs	Married	Single	Per cent married	Per cent single	Status unknown	Total no cases	Per cent
20-24	2	2	2	2		4	4
25-34	46	13	4 8	1 4		59	6 2
35-44	227	37	23 9	3 9		264	27 8
45-54	291	34	30 6	3 6	1	326	34 3
55-64	176	26	18 5	2 7		202	21 3
65 and over	77	6	8 1	6	1	84	8 8
Subtotal	819	118	86 1	12 4	2	939	98 8
Males	9		9			9	9
Unknown	2		2			2	2
Totals	830	118	87 2	12 4	2	950	99 9

In working per cents used 821 as total instead of 830 because 9 were males

Ten-year age groups in this table obtained by transforming Table IV from five-year to ten-year groups in order to compare Table VI with Table V

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TABLE VII—*A Hypothetical Case, Showing the Number of Married and Single Women That Should Be in Each Age Group if the Ratio of Married to Single Is the Same As That for All Women in the United States*

Age in yrs	Married women	Single women	Total
20-24	2	2	4
25-34	48	11	59
35-44	234	30	264
45-54	295	31	326
55-64	185	17	202
65 and over	78	6	84
Totals	842	97	939*

\* Eleven cases were omitted because nine were males and the marital status of two was unknown

By taking the total number of women having carcinoma of the breast in each age group and applying to it the per cents given in the columns Married and Single in Table V, the number of married and single women that would be in each age group, if they were not affected by carcinoma of the breast, is determined. These figures are given in Table VII. By comparing Tables VI and VII, it is seen that the number in each age group having carcinoma of the breast is almost identical with the group unaffected by it. This is shown graphically in Chart B.

TABLE VIII—*Distribution by Age Groups of Females of All Classes in the United States 1920\**

Age in yrs	Per cent of females in each age group
Under 5	11.0
5-14	21.1
15-24	18.3
25-34	16.4
35-44	13.0
45-54	9.4
55-64	5.9
65 and over	4.7

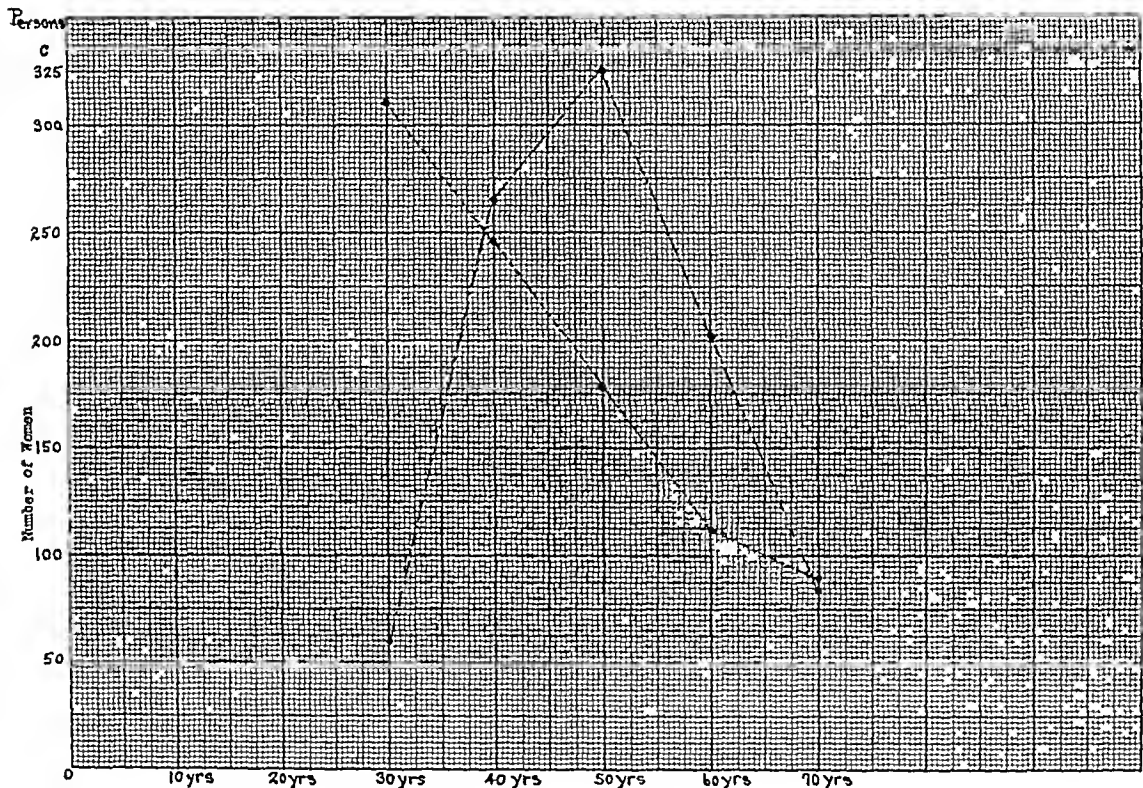
\* From Table II, Distribution by Broad Age Groups for Population Classes by Sex, for the United States, 1910 and 1920, p. 155. Fourteenth Census of the United States, 1920, vol. II, Population.

Women of twenty-five years of age and older form 49.4 per cent of all the females in the United States. Since in the carcinoma of the breast group there are 935 women, twenty-five years of age or more, this number represents the same 49.4 per cent. The size of a group of women, in which 935 are twenty-five years old or older is 1893, because  $935 \div 49.4 = 100$ . By applying the per cents given in Table VIII for each age group to 1893 the number of women unaffected by carcinoma of the breast is determined for each age group as shown in Table IX.

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white, a ratio of 1 3, which is much higher than the normal distribution in the population as a whole. This would tend to suggest that the incidence of carcinoma of the breast is higher among colored than white women. The proportion of colored to white women admitted to the Johns Hopkins Hospital is 1 3 demonstrating that the incidence of carcinoma of the breast in the two races is about the same for this group of cases.

In an attempt to find out if carcinoma of the breast was selective for certain age groups a study was made of the age distribution of women in the United States as a whole and a comparison was made with the age distribution of this group of 950 cases. The fact that 49.4 per cent of all the females in the United States are twenty-five years of age or older enabled us to compare



GRAPH C—Diagram showing the selection carcinoma of the breast as to age. — — — — — Shows the age distribution of 935 women according to the age group percent from the 1920 census United States. — — — — — Shows the age distribution of 935 women of the same age group who had carcinoma of the breast.

for each age group the women affected and unaffected with carcinoma of the breast. The method by which these comparisons were worked out mathematically may be observed in Tables VIII, IX and X, with their legends, and Graph C.

It will be noted that there is a constant diminution in the number of women in the United States in each age group from twenty-five years of age on. However, in the series affected with carcinoma of the breast there is an increase in the number of cases for each age group from twenty-five years of age on, reaching a maximum at about fifty, from which there is a gradual decrease. The greater number of cases of carcinoma of the breast in this series occurred between thirty-five and sixty-four.

Carcinoma in the male breast occurred only nine times in 950 cases, the details of which may be seen in Table XI

TABLE IX—*A Hypothetical Case Showing the Age Distribution of 935 Women over Twenty-five Years of Age, if Their Ages Were Distributed in Accordance with the Age Distribution of Women in the United States*

Age in yrs	No of women	Per cent in each age group
25-34	310	16 4
35-44	246	13 0
45-54	178	9 4
55-64	112	5 9
65 and over	89	4 7
Totals	935	49 4

If 935 women represent 49 4 per cent of total, then the total is 1893 for  $935 \times 49 4$

The distribution according to the age incidence of women unaffected by carcinoma of the breast in a group of which the total is 1893 distributed according to the distribution of women in the United States. There is a constant diminution in the number of women in each age group from twenty-five years of age on

*Anatomical and Pathological Classification*—The situation of the tumor, as shown in Table XII, seemed to be about as frequent in the right as in the left breast and in only forty-five cases (4 7 per cent) was the disease bilateral. Of these only fourteen (1 5 per cent) had bilateral breast carcinoma on admission. In twenty-four cases it was possible to find the actual

TABLE X—*Frequency Distribution of 935 Cases of Carcinoma of the Breast, over Twenty-five Years of Age, as to Age of Incidence Johns Hopkins Hospital (1889-1931)*

Age in yrs	No of patients	Per cent
25-34	59	6 3
35-44	264	28 2
45-54	326	34 9
55-64	202	21 6
65 and over	84	9 0
Totals	935*	100 0

\* Fifteen cases omitted, 9 males, 2 ages unknown, 4 were between the ages of twenty to twenty-four years. These last were omitted because the per cents in the United States Census were given in ten-year age groups

The actual distribution of the cases of carcinoma of the breast in this series of 950 cases according to their age incidence. There is an increase in the number of cases of carcinoma of the breast from twenty-five years of age on, reaching a maximum about fifty, from which there is a gradual diminution. The greater number of cases of carcinoma of the breast occur between thirty-five and sixty-four. This is not only apparent but actual, as shown by Graph C. Compare this table with Table IX

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time between the two admissions or operation. In fourteen cases, or 58 per cent, the remaining breast was involved by the end of the second year, in eighteen cases, or 75 per cent, by the end of the fifth year (Table XIII). However, in two cases the second breast did not become involved until eighteen

TABLE XI — *Classification of Male Cases of Carcinoma of the Breast, as to Age, Marital Status and Color*  
*Johns Hopkins Hospital (1889-1931)*

Yrs of incidence	Age	Married	Single	White	Black	Patient's condition from most recent report
1892	48	1		1		Incomplete operation
1893	64	1		1		Dead
1898	47	1		1		Dead
1900	71	1		1		Recurrent, prim oper elsewhere
1903	69	1			1	Dead
1917	54	1			1	Dead
1922	66	1		1		Lost track of patient
1923	64	1		1		Not treated
1926	63	1			1	Well
Totals		9		6	3	

Average age incidence in male breast is greater than female. Two-thirds are over sixty years of age.

and twenty years after the first operation. It is, of course, possible that these may be instances of another growth *de novo* instead of metastases from the primary one. The average length of life of the patients with bilateral involvement was 5.69 years, and therefore longer than for cases of carcinoma of

TABLE XII — *Situation of Tumor in 950 Cases of Carcinoma of the Breast*  
*Johns Hopkins Hospital (1889-1931)*

Situation of tumor	No of cases	Per cent of cases
Right breast	442	46.5
Left breast	463	48.7
Both breasts	45	4.7
Totals	950	99.9

the breast as a whole because 42 per cent of the former had already lived for two or more years before the second breast became involved and in 25 per cent at least five years. This average life is computed from Table XIV.

The pathological classification of this group of 950 cases is interesting primarily because excepting eleven, or 1.2 per cent, doubtful cases and 123, or 12.9 per cent, unknown, as shown in Table XV, the remainder are unques-



TABLE XIII — *Bilateral Cases of Carcinoma of the Breast, Showing the Time That Elapsed between the First and Second Admissions or Operations*

Time in yrs	No of cases
1	6
2	8
3	1
4	2
5	1
6	2
7	1
10	1
18	1
20	1
Bilateral at admission	14
Unknown	7
Total	45

In several incidences there was no second operation

In 45 cases out of 950, or 4.7 per cent, the disease was bilateral. Fourteen or 15 per cent had bilateral breast carcinoma on admission. In twenty-four cases it was possible to find the actual time between the two admissions or operations. In fourteen cases or 58 per cent the second breast was involved by the end of the second year. In eighteen or 75 per cent by the end of the fifth year. In two cases the second breast did not become involved until eighteen and twenty years after operation.

TABLE XIV — *Length of Post-operative Life for the Cases of Carcinoma of the Breast Where There Was a Bilateral Involvement*

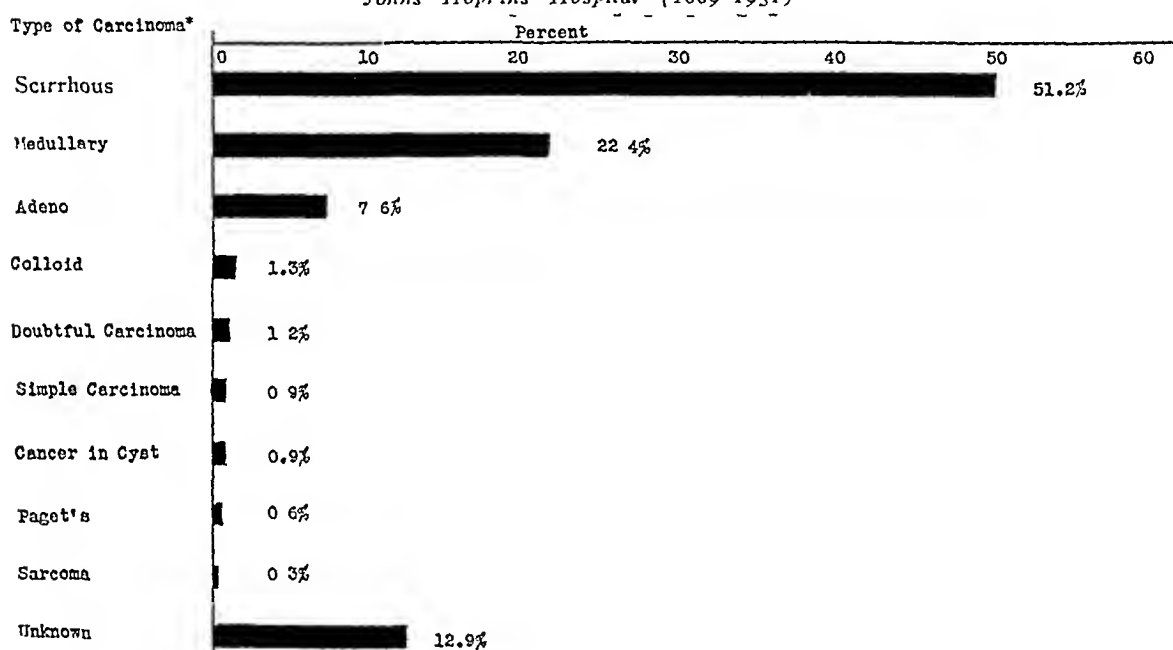
Post-oper life in yrs	No of cases
1	6
2	6
3	4
4	3
5	3
6	4
7	—
8	2
9	1
10	1
11	1
12	—
13	1
—	—
19	1
20	2
Unknown	10
Total	45

The average length of life of the cases with bilateral involvement was 5.69 years, therefore greater than for the cases of carcinoma of the breast as a whole because 42 per cent of these cases had already survived two years before the second breast was involved, and in 25 per cent at least five years.

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tionably cancer. In the remaining group, by far the greater number consisted of scirrhus carcinoma (51.2 per cent) with medullary next in frequency (22.4 per cent). Adeno-carcinoma followed with 7.6 per cent and colloid carcinoma with 1.3 per cent. Graphically, these proportions are well shown in Bar Diagram D. In general, the medullary type was somewhat more rapid in its growth and the tumor as a rule larger on admission, with a slightly diminished frequency of local recurrence, the latter characteristic being probably due to the relative short post-operative longevity associated with this type. In the scirrhus type, on the other hand, there was a higher incidence of local recurrence and a greater post-operative longevity. The

BAR DIAGRAM D  
*Frequency Distribution of 950 Cases of Carcinoma of the Breast According to the  
Pathological Diagnosis  
Johns Hopkins Hospital (1889-1931)*



\* There was one case (or percent) of each of the following types: Colloid adeno, comedo, intracystic papilloma, papillary carcinoma, scirrhus adeno and spinal cell.

adeno- and colloid carcinomata were the most favorable for surgical treatment in that their post-operative life was longer and the recurrences much less. Attention is called to the fact, however, that these various classifications are purely arbitrary and in many instances shade over from one into another. We have a feeling of great uncertainty as to whether or not the biological characteristics of a malignant growth can be prognosticated from an objective histological examination. An example of the futility of such conjectures in our present state of knowledge may be observed in two cases of this series. In one the tumor was small and had existed for forty years before operation, after which the patient lived for many years. In the other, the tumor was very large and had been present for less than three months. Following operation the patient died from generalized metastases within six months. However, both tumors were infiltrating scirrhus carcinomata indistinguishable in their microscopical pattern. In general it may be stated for this series of

cases that the very cellular types of tumors were as a rule more fulminating and malignant than those less cellular, but attempts to grade the relative malignancy or benignancy to a finer definition proved unsuccessful

*Surgical Treatment*—The main standard by which the operative treatment of carcinoma of the breast may be judged is the cure of the disease locally. The better operation is that one associated with the smallest percentage of local recurrence. The operator cannot be held responsible for undiscoverable metastases, either regional or remote, but should be held to account for a local recurrence. Some confusion has resulted in the past concerning

TABLE XV—*Frequency Distribution of 950 Cases of Carcinoma of the Breast According to the Pathological Diagnosis Johns Hopkins Hospital (1889-1931)*

Type of carcinoma	Total no of cases	Per cent of cases
Simple	9	9
Scurrhous	486	51.2
Medullary	213	22.4
Adeno	72	7.6
Paget's	6	6
Cancer in cyst	9	9
Colloid	12	1.3
Scurrhous adeno	1	1
Colloid adeno	1	1
Comedo	1	1
Sarcoma	3	3
Intracystic papilloma	1	1
Doubtful	11	1.2
Papillary	1	1
Spinal cell	1	1
Unknown	123	12.9
Totals	950	99.9

See also Bar Chart D

the definition of the terms denoting recurrences and metastases, and in order that the standards by which this group of cases were classified may be clearly understood these terms are defined according to our interpretation. By local recurrence is meant the reappearance of carcinoma at any time following the removal of the primary tumor, by operation, in the operative field, i. e., in the apparent or buried scar. The more radical the operation, the more liberal the interpretation of the term, local recurrence. Regardless of the number of years that have elapsed since the primary operation, a return of carcinoma within the limits of the operative field should be considered a reoccurrence of the primary tumor and not a growth *de novo*. We have observed a local recurrence in the scar following an operative procedure over twenty years after the primary operation, and others after five, ten to fifteen

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years It would seem likely that these local recurrences indicate growths either from inoculations of the operative field with carcinoma at the operation, or regional extensions from the primary growth, and therefore in either event represent a continuation of the disease in that region uninterrupted by the operative procedure Why their growth is so retarded after transplantation from the primary tumor to a new environment is difficult to determine It is, of course, possible that the primary growth was equally slow before the patient became aware of its presence Again, carcinoma seems to grow less rapidly in certain tissues, notably skin, as evidenced by the slow growth of lenticular skin metastases from a rapidly growing primary tumor We have dropped the term *regional recurrence* for *regional metastases* It was felt that involvement of the regional glands, *i e* , supraclavicular or mediastinal, involvement of the opposite breast, or the skin in the immediate environment, was due undoubtedly to regional metastases The term, *remote metastases*,

TABLE XVI—*Frequency Distribution of 950 Cases of Carcinoma of the Breast as to With or Without Metastases at Time of Operation*  
*Johns Hopkins Hospital (1889-1931)*

Metastases	Total no of cases	Per cent of cases
With metastases at the time of operation	678	71.4
Without metastases at the time of operation	183	19.3
Unknown	89	9.4
Totals	950	100.0

These figures were arrived at by a study not only of the physical examination of each of the patients but also the operative and pathological findings as well As would be expected a large number of patients had regional metastases that were unsuspected clinically

includes all metastatic growths far removed from the region of the operative field

Longevity is also one of the criteria by which to judge the worth of an operative procedure, but not, it would appear, as important as the question of local recurrence The reasons for this are obvious ones, among them being death from other causes that prevent the patient from living long enough to have a recurrence It also is well known that in some unusual cases of breast tumors that have not been operated upon the patients have lived for years, one known to us for twenty-five years, her death being due to old age with senile changes So that in at least a small percentage of cases interruption of the growth by a surgical procedure does not necessarily mean a successful curative operation Again, it is surprising how long some patients have lived with one or more local recurrences, the carcinoma thus having an uninterrupted continuity

Patients operated upon late in life when their normal expectancy has been almost completed will die of senile changes, although there may or may not be a complete obliteration and local cure of the carcinoma. Thus the later in life the patient is operated upon the shorter the normal life expectancy and also the post-operative longevity. So that in this group of patients longevity

TABLE XVII—*Duration of Life in Years, the Absolute Number of Patients That Died within Various Years after an Operation for Carcinoma of the Breast, the Per Cent of Patients Dead in Each Period, the Per Cent Alive in Each Period*  
*Johns Hopkins Hospital (1889-1931)*

Length of life	The absolute no of patients who died in each period	Per cent of patients who died in each period	Per cent of patients alive in each period
In hospital	25	6.4	93.6
6 months or less	69	17.6	82.4
1 year or less	127	32.3	67.7
2 years or less	225	57.3	42.7
3 years or less	269	68.4	31.6
4 years or less	306	77.9	22.1
5 years or less	322	81.9	18.1
6 years or less	338	86.0	14.0
7 years or less	351	89.3	10.7
8 years or less	360	91.6	8.4
9 years or less	364	92.6	7.4
10-14 years or less	377	95.9	4.1
15-19 years or less	382	97.2	2.8
20-24 years or less	390	99.2	.8
25-29 years or less	391	99.5	.5
30-32 years or less	393	100.0	0
Totals	393*	100.0	0

\* Length of post-operative life unknown in twenty-seven cases

This table is made from the group of 420 patients who comprised the series of known dead. It is to be noted that this chart is cumulative, that is, all the patients and the per cents of previous years are added on for each specific year group. That is, in the five year group there are included all the deaths which occurred not only in the hospital but those which occurred in six months or less, one year, two years, three years, four years, and also during the fifth year. Thus by the end of the fifth year 322 patients or 81.9 per cent had succumbed while 18.1 per cent remained alive. Attention is called to the fact that each year up to the end of the second year the mortality per year increases quite pronouncedly but diminishes after the second year. In other words, if the patient survives the first two years his chances of living are much improved. See Graphs E and F.

would be a very unreliable index to the efficacy of a surgical procedure. Further, the merits of an operative procedure cannot be correctly ascertained if the affection for which it is applied is of too long standing and too extensive. It is to be noted that in this series of cases a large majority of the patients were in the public ward and in over 53 per cent of these the tumors were

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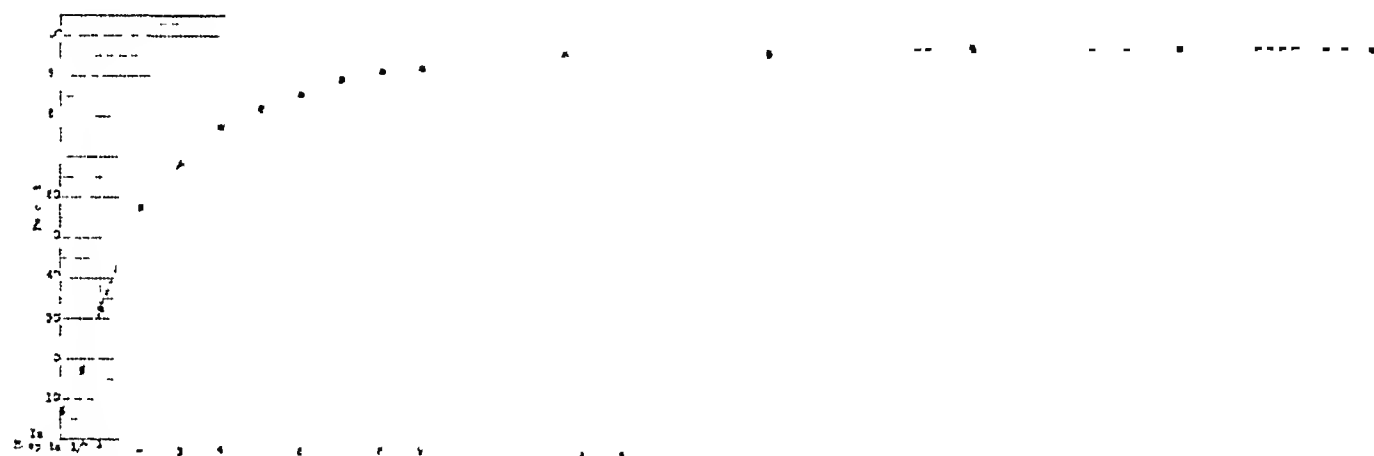
large and 71.4 per cent had regional metastases at the time of operation (Table XVI)

*An analysis of the ultimate results obtained by the surgical treatment of carcinoma of the breast in this series of 420 cases comprising the known dead group is shown in Table XVII Graphs E and F This includes all types of operative procedures and it is observed that the operative mortality was 6.4 per cent, twenty-five patients dying as a result of the operation Of these, seven died of pulmonary embolism, which seems remarkable when one considers that in the majority of cases the axillary vein was manipulated freely Three succumbed to pneumonia, five died of infected wounds, two of myocardial insufficiency, three of post-operative shock, and in five the cause was unknown By the end of the second year 225 patients (53.3 per cent) had died This is also shown in Table XIX, which is non-cumulative, and in Graph G The greatest number of deaths occurred not only by, but also in, the second year, but after this the mortality per year fell off quite rapidly Again referring to Table XVII, it is to be noted that by the end of five years 81.9 per cent had died, leaving 18.1 per cent alive In the 420 patients known to be dead the greatest length of life was thirty-two years, to which period two patients survived One operated upon by Doctor Halsted in 1895 at the age of fifty-four succumbed, at the age of eighty-six, to carcinoma of the liver without any local recurrence The other was operated upon by Doctor Cushing in 1898 at the age of forty-five and died at the age of seventy-seven of some cause unknown Undoubtedly, as will be shown, the majority of these patients died of or with carcinoma present but possibly some, particularly the older ones, succumbed from other causes*

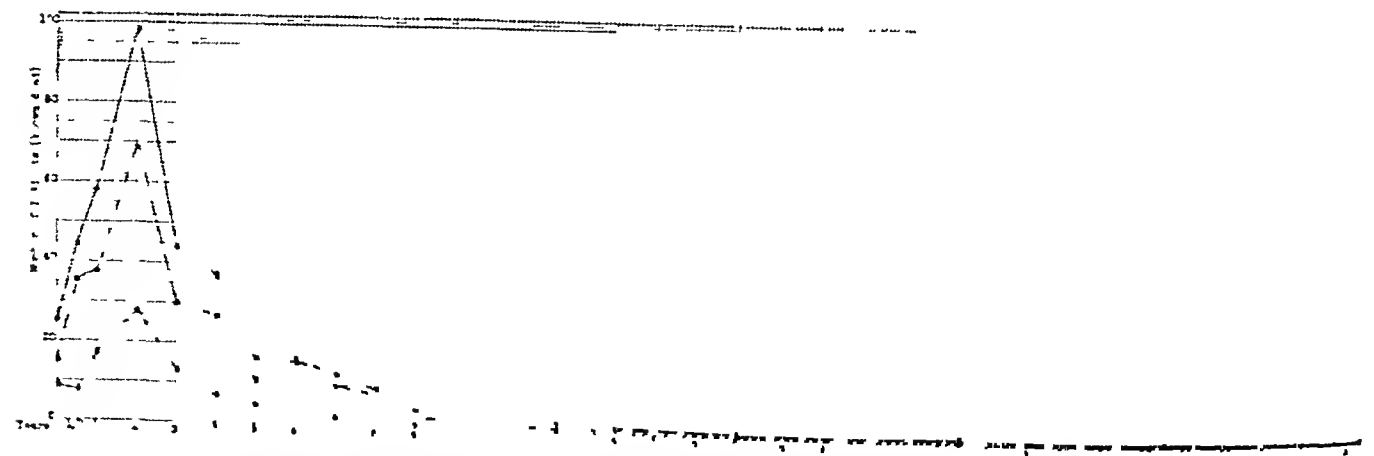
*A comparison of the types of operations performed in this series of 950 cases, as to post-operative longevity, is of more than usual interest because of the fact that there have been very pronounced opinions in this clinic as to the efficacy of one type of operative procedure in comparison with the other The complete operation described and performed by Doctor Halsted differed primarily in the removal of a much larger area of skin with the subsequent defect repaired by grafting, more frequently by the use of the Thiersch, occasionally with Reverdin grafts The radical operation performed by others allowed sufficient skin to remain in order that the various incisions might be closed without grafting In this study the former have been designated as *Thiersch graft* and the latter as *closed plastic operations* From Tables XVIII and XIX and Graph G a comparison of the results of the two operative procedures may be observed, for the group of 413 patients of the known dead series Three hundred three patients were operated upon by the Halsted Thiersch graft method and 106 cases by the closed plastic, while in four Reverdin grafts were used This is a ratio of about 3.1 in favor of the Thiersch graft operation From columns four and five, Table XIX, the average length of life following a Thiersch graft and closed plastic operation was calculated and found to be 3.82 years for the former and 3.15 for the*



GRAPH E—Years of post operative life Showing the percent of patients having carcinoma of the breast that were alive in each successive year



GRAPH I—Years of post operative life, showing the total percent of patients having carcinoma of the breast that had died by the end of each successive year



GRAPH C—Diagram showing length of life after an operation for carcinoma of the breast, closed plastic operation — — — — — Both types of operation ————— \* In hospital

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latter—a difference of 0.67 of a year or practically eight months in favor of the Thiersch graft procedure, which, although small, is a definite difference. It is to be noted that if one included in the Halsted Thiersch graft group the cases in which Reverdin grafts were used, the difference in longevity would be even more in favor of the type of operation in which grafting has been made necessary by the large sacrifice of skin, as in the Thiersch graft group. This difference in longevity is essentially negative from a statistical point of view, but when one takes into consideration the fact that the Thiersch graft operation was performed previous to 1925 on by far the greater majority of public-ward cases in which the disease was very extensive, and, as a rule, of long duration, whereas the closed plastic procedure was performed to a large extent on private patients in whom the tumors were usually smaller and the

TABLE XVIII —*Frequency Distribution of 950 Cases of Carcinoma of the Breast  
as to Type of Operation*  
*Johns Hopkins Hospital (1889-1931)*

Type of operation	Total no of cases	Per cent of cases
Complete, Thiersch graft	524	55.2
Complete, closed plastic	274	28.8
Reverdin graft	4	4
Incomplete operation	40	4.2
Not treated	72	7.6
Inoperable	29	3.1
Arm amputation	2	2
Type unknown	5	5
Totals	950	100.0

See Graph G

disease less extensive, one realizes that the Halsted Thiersch graft procedure has stood a more severe test, and achieved more than the figures 0.67 would denote. Attention is also called to the fact that those favoring the closed plastic procedure resorted to grafting only when the malady was so extensive as not to admit of a plastic closure. For this reason, all the unfavorable cases were relegated to the Thiersch graft operation. It should also be stated that the follow-up examination of the patients submitted to the Halsted Thiersch graft operation, due to the persistent efforts of Doctors Bloodgood and Halsted, has been much more active and thorough than with the closed plastic cases. Thus in the former group unfavorable developments were more accurately detected and recorded. In the last six years, closed plastic operations have been performed to a large extent on public-ward patients who have not lived long enough in the majority of instances to have died of the disease *in situ*, through the crucial two-year period, or to have developed complications, whereas the opposite is true for the Thiersch graft group. By this is meant



TABLE XIX — Frequency Distribution of 120 Cases (Known Dead) Showing the Length of Life after Operation for Carcinoma of the Breast  
*Johns Hopkins Hospital (1889-1931)*

Length of life after oper	Type of Operation						Per cent patients dead
	Type of oper unknown	No patients having Reverdin graft	No patients dead, having arm amputation	No patients dead, having complete Thiersch graft	No patients dead, having complete closed plastic	Total No patients dead, operated on for carc breast	
In hospital	(1) 1 (inoperable)	(2)	(3)	(4)	(5)	(6)	(7)
Six months or less				15	9	25	60
During 1st year				36	8	44	105
During 2nd year		2	1	38	17	58	138
During 3rd year	1			70	28	98	233
During 4th year	2	1		30	13	44	105
During 5th year				27	7	37	88
During 6th year				11	5	16	38
During 7th year	1			16	—	16	38
During 8th year				10	2	13	31
During 9th year				8	1	9	21
10th to 14th year				3	1	4	10
15th to 19th year		1		7	6	13	31
20th to 24th year				3	1	5	12
25th to 29th year				7	1	8	19
30th to 34th year				1	—	1	2
Unknown	1			2	2	2	5
Total	6	4	1	303	106	420	1000

This table is not cumulative and demonstrates the post-operative longevity in the different years following operations of both the Thiersch graft and the closed plastic types. The second year, as shown by Graph G, was the year in which the greatest number of deaths occurred. Following this the mortality per year fell off very rapidly from 23.3 per cent in the second year to 10.5 per cent in the third, 8.8 per cent in the fourth, etc. These figures are plotted in a straight line, the top curve of Graph G. From this point on the data are collected in five-year periods because of the scarcity of cases. This table also demonstrates the relative merits of the two operative procedures. Three hundred and three were operated upon by the Halsted Thiersch graft method and 106 by the closed plastic. In four Reverdin grafts were used. The ratio of the Thiersch graft to the closed plastic procedure is about 3:1. From columns 4 and 5 the average length of life following the Thiersch graft and the closed plastic operation is calculated and found to be 3.82 years for the former and 3.15 for the latter.

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that the very few patients having been so operated upon by this latter method since 1925 have had at least six years of post-operative life and freedom from a local recurrence Statistically, these recent cases since 1925 are a distinct

TABLE XX—*Number of Operations for Carcinoma of the Breast Performed by Various Surgeons at the Johns Hopkins Hospital, and the Number of Cases Where There Was a Local Recurrence (1889-1931)*

Operator	No of opera- tions	No of local recurrences	Per cent local recurrences
A	215	48	22 3
B	132	28	21 2
C	46	8	17 4
D	22	7	31 8
E	39	3	7 7
F	17	5	29 4
G	24	5	20 8
H	5	1	20 0
I	32	6	18 8
J	19	2	10 5
K	25	6	24 0
L	36	4	11 1
M	34	3	8 8
N	3	—	—
O	12	—	—
P	20	5	25 0
Q	19	2	10 5
R	36	2	5 6
S	11	—	—
T	1	—	—
U	16	1	6 3
V	19	2	10 5
W			
X	9	—	—
Y	4	—	—
Z	11	—	—
Aa	8	1	12 5
Bb	5	3	60 0
Cc	1	—	—
Dd	1	—	—
Ee	4	—	—
Ff	3	—	—
Gg	4	1	25 0
Hh	1	1	100 0
Ii	1	—	—
Jj	1	—	—
Kk	1	—	—
Ll	1	—	—
Mm	1	—	—
Not treated	72		
Omitted	39		
Totals	950	144	

advantage in favor of the closed plastic group but show rather to the disadvantage of the Halsted Thiersch graft series. These points are brought out because the field of usefulness in surgery of numerical or statistical computations is quite limited owing to the great variation in the type of patient as well as the extent of the disease. It also should be considered in the light of all possible information which may have some bearing on the circumstances involved. As stated before, however, longevity is only one of the criteria by which an operative procedure for the cure of carcinoma of the breast should be judged. It is felt that this series of 413 cases, in which the post-operative length of life is known, is a fairly good test of both operative procedures, for the cases extend over a period of forty-two years and were dealt with by surgeons who performed the radical removal of the breast together with the pectoral muscles and axillary contents in essentially the same manner. They differed only in the amount of skin removed with the breast and therefore in the method of closure. The list of operators is given in Table XX. *A comparative study of the two operative procedures with reference to the yearly death rate*, using the cumulative method, may be seen in Table XXI. In each period, excepting six months, eight and nine years, respectively, the percentage of patients who died after the Halsted Thiersch graft operation is smaller for each successive period than after the closed plastic operation. In these periods noted, *i e.*, six months, eight and nine years, the difference in the percentage of deaths was negligible. The main difference is from the first year through the fifth, when per year there are fewer dying after the Halsted Thiersch graft than after the closed plastic operation, or a greater percentage of patients submitted to the Thiersch graft operation for carcinoma of the breast will live through the first five years than those on whom a closed plastic operation was performed. However, from the sixth year on the difference in the percentage living is practically negligible. In those who have lived five years the longevity is unaffected by the type of operation. As will be shown later, the higher yearly mortality for the closed plastic operation during the first five years is probably due to the effect of local recurrences which occur and run their course within that period of time. By the end of twenty-four years all of those operated upon by the closed plastic method had died, whereas it was not until the end of the thirty-second year following operation that the last patient died who had been operated upon by the Thiersch graft method. It is to be said that this difference in the total longevity following the two operative procedures was caused by the long life of only three patients. Their total length of post-operative life was ninety-one years, which would increase the average length of life of the entire Thiersch graft group approximately one-third of a year, or four months. These are graphically shown in Chart H. It may, therefore, be suggested that in this group the chances of a patient to live through the five-year period were greater if they had a larger area of skin removed and with the closure made by grafting than if a plastic operative procedure was employed.

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After five years their chances of surviving were about equal for the two operative procedures

*The effect on post-operative length of life of regional metastases, i e, axillary and supraclavicular glands of the same side, is shown in Table XXII* Of

TABLE XXI—*Frequency Distribution of 409 Cases (Known Dead) of Carcinoma of the Breast Showing the Length of Life after Thiersch Graft Operations and after Closed Plastic Operations*  
*Johns Hopkins Hospital (1889-1931)*

Length of life after oper	Cases of Thiersch graft oper cumulative	Cases of closed plastic cumulative	Per cent Thiersch graft	Per cent closed plastic
In hospital	15	9	5 3	9 1
6 months or less	51	17	18 0	17 2
1 year or less	89	34	31 3	34 3
2 years or less	159	62	56 0	62 6
3 years or less	189	75	66 5	75 8
4 years or less	216	82	76 1	82 8
5 years or less	227	87	79 9	87 9
6 years or less	243	87	85 6	87 9
7 years or less	253	89	89 1	89 9
8 years or less	261	90	91 9	90 9
9 years or less	264	91	92 9	91 9
10-14 years or less	271	97	95 4	98 0
15-19 years or less	274	98	96 5	99 0
20-24 years or less	281	99	98 9	100 0
25-29 years or less	282	—	99 2	—
30-34 years or less	284	—	100 0	—
Totals	284	99		

A comparative cumulative study of the length of life following operation by the two procedures has been made in a similar series of the known dead analyzed in Table XIX consisting of 303 cases operated on by the Halsted Thiersch graft and 106 by the closed plastic, eliminating 11 cases because in 5 the type of operation was unknown. Four were Reverdin grafts, one was inoperable, and an arm was amputated in one. The percentage of patients dying after the Halsted Thiersch graft operation is smaller and therefore the percentage of patients living is greater for each successive period than following the closed plastic operation with the exception of the periods, six months and eight and nine years. In these latter instances the difference in the percentage of cases dying following the two operative procedures is negligible. The greatest difference in the per cents of those dying after the two types of operations is between the first and fifth year, which difference favors the Thiersch graft. From the seventh year on the difference in the percentage of those dying is never greater than two. From the sixth year on the difference in the percentage living following the two procedures is negligible. This is graphically shown by Chart H.

the group of 420 known dead 379 cases were available for study, the data being insufficient in forty-one cases. It is interesting to note that twenty-three patients having regional metastases died in the hospital following operation.

whereas not a single case without metastases contributed to the immediate operative mortality. It is to be recalled that out of the entire group of 950 cases there were only twenty-five deaths in the hospital. Thus, in all but two cases concerning which there were insufficient data, of the group constituting the hospital or operative mortality, there were regional metastases. This may be explained not only by the fact that patients with extensive metastases are as a rule poorer operative risks but also by the fact that in these cases the difficulties of dissection are markedly increased, thus prolonging the operative procedure. Of this group of 379 patients, 326 had metastases and

TABLE XXII—*A Classification of 379 Cases of Carcinoma of Breast as to the Length of Post-operative Life and the Presence and Absence of Regional Metastases (All These Patients Are Known to Be Dead)*

Length of post-oper life	With metastases (1)	Without metastases (2)	Total
In hospital	23	—	23
6 months	41	2	43
1 year	51	4	55
2 years	89	9	98
3 years	34	9	43
4 years	28	5	33
5-9 years	43	13	56
10-14 years	7	6	13
15-19 years	4	—	4
20-24 years	4	4	8
25-29 years	—	1	1
30-34 years	2	—	2
Totals	326	53	379

Of the 420 dead, forty-one cases were eliminated because of insufficient data, leaving 379 for examination. The ratio of patients with metastases to those without is 6 : 1. 326 : 53. This ratio is not maintained but markedly increased for those cases with metastases during the first two years, dropping after the completion of the second year. It is evident that about two-thirds of the patients with metastases have died by the end of the second year while less than one-third of those not having metastases have succumbed at this time.

fifty-three were found to be free from them, a ratio of 6 : 1. It would be expected that this ratio of 6 : 1 should be maintained in the yearly death rate if the metastases *per se* played no rôle in the post-operative longevity. This, however, is found not to be true. The ratio of 6 : 1 is not borne out but markedly increased for these cases with metastases during the first two years, dropping after the end of the second year. As shown previously, 71.4 per cent of the patients of this series have had regional metastases at the time of operation. It can be seen at a glance in Table XXII that about two-thirds of the patients with metastases have died by the end of the second year, while less than one-third of those not having regional metastases have

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TABLE XXIII.—Showing the Length of Life after an Operation for Carcinoma of the Breast, (a) Having Either a Thiersch Graft or Closed Plastic Operation, (b) With or without Metastases at the Time of the Operation. The Number of Patients is given in Absolute Numbers and in Percentages. Johns Hopkins Hospital (1889-1931)

No of yrs alive	Thiersch graft		Closed plastic		Thiersch graft		Closed plastic	
	With metastases		Without metastases		With metastases		Without metastases	
	No cases	Per cent	No cases	Per cent	No cases	Per cent	No cases	Per cent
Unknown	18	6.8	1	2.9	7	8.1	—	—
In hospital	15	5.7	—	—	8	9.3	—	—
6 months	33	12.5	2	5.7	8	9.3	—	—
1 year	34	12.8	4	11.4	17	19.8	—	—
2 years	67	25.3	3	8.6	22	25.6	—	—
3 years	25	9.4	5	14.3	9	10.5	—	—
4 years	22	8.3	4	11.4	6	7.0	—	—
5-9 years	37	14.0	10	28.6	6	7.0	—	—
10-14 years	5	1.9	2	5.7	2	2.3	—	—
15-19 years	3	1.1	—	—	1	1.1	—	—
20-24 years	4	1.5	3	8.6	—	—	—	—
25-29 years	—	—	1	2.9	—	—	—	—
30-34 years	2	.8	—	—	—	—	—	—
Totals	265		35		86		19	
		300				105		
				405				50
						47		97

This table includes not only the known dead but the well, of which there are ninety-seven cases. The total thus comes to 517 but fifteen cases were omitted from the chart because in four of these it was not known whether the patient had metastases at the time of operation. In five cases the type of operation was not known. Two were inoperable because of the very extensive involvement of the breast together with a great lymphoedema of the arm, which was amputated as a palliative measure. In four cases Reverdin grafts were used. "X" in the table means the length of life following operation was unknown. The total number of cases in each group is given at the end of each division, thus the dead and living are separated to be again divided into two main groups, *i.e.*, those having the Thiersch graft and the closed plastic operations. These are further divided with reference to regional metastases.

succumbed by this time. It would seem likely, therefore, that the high mortality of 57.3 per cent for the group as a whole, occurring at the end of the second year, is in a major part due to the high death rate of those having regional metastases at the time of operation.

*A comparative study was made of the relative merits of the closed plastic and the Halsted Thiersch graft operations in regard to the post-operative longevity of these patients, with and without regional metastases. For this study the group of patients constituting the living and known dead were used,*

TABLE XXIV—*Showing the Number of Patients, the Per Cent Dead and the Per Cent Alive in Various Durations of Life after an Operation for Carcinoma of the Breast, (a) Having Either a Thiersch Graft or Closed Plastic Operation, (b) With Metastases. All These Patients Are Known to be Dead*  
*Johns Hopkins Hospital (1889-1931)*

Length of life after operation	With metastases					
	Thiersch graft			Closed plastic		
	No of patients	Per cent dead	Per cent alive	No of patients	Per cent dead	Per cent alive
In hospital	15	5.3	94.7	8	9.3	90.7
6 months or less	48	18.1	81.9	16	18.6	81.4
1 year or less	82	30.9	69.1	33	38.4	61.6
2 years or less	149	56.2	43.8	55	64.0	36.0
3 years or less	174	65.7	34.3	64	74.4	25.6
4 years or less	196	74.0	26.0	70	81.4	18.6
5-9 years or less	233	87.9	12.1	76	88.4	11.6
10-14 years or less	238	89.8	10.2	78	90.7	9.3
15-19 years or less	241	90.9	9.1	79	91.9	8.1
20-24 years or less	245	92.5	7.5	—	—	—
25-29 years or less	—	—	—	—	—	—
30-34 years or less	247	93.2	6.8	—	—	—
Unknown	18	6.8	—	7	8.1	—

This table is cumulative and demonstrates the relative merits of the two operative procedures for the 326 patients known to be dead in whom there were regional metastases. It is to be noted that in the Thiersch graft group the percentage dying in each successive year is lower than the percentage dying in the closed plastic group.

giving a total of 502 cases, after removing fifteen patients concerning whom there were insufficient data. In Table XXIII it may be noted that of the known dead, 405 patients having regional metastases before operation, the percentage of patients that have died in the succeeding year following operation was approximately the same after the two operative procedures. Of this same group of known dead in whom there were no regional metastases previous to operation, the percentage dying by the end of the second and third years was lower for the Halsted Thiersch graft group than the closed

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plastic, but higher for the period of four to nine years and again lower for the ten to fourteen years. Again, it is to be noted that over 50 per cent of the patients in this group that have been operated upon were dead by the completion of the second year and of this group the majority succumbing by this time had been operated upon by the closed plastic method. For the ninety-seven patients living it is to be noted that a greater number of patients have lived a greater number of years in the Thiersch graft group than in

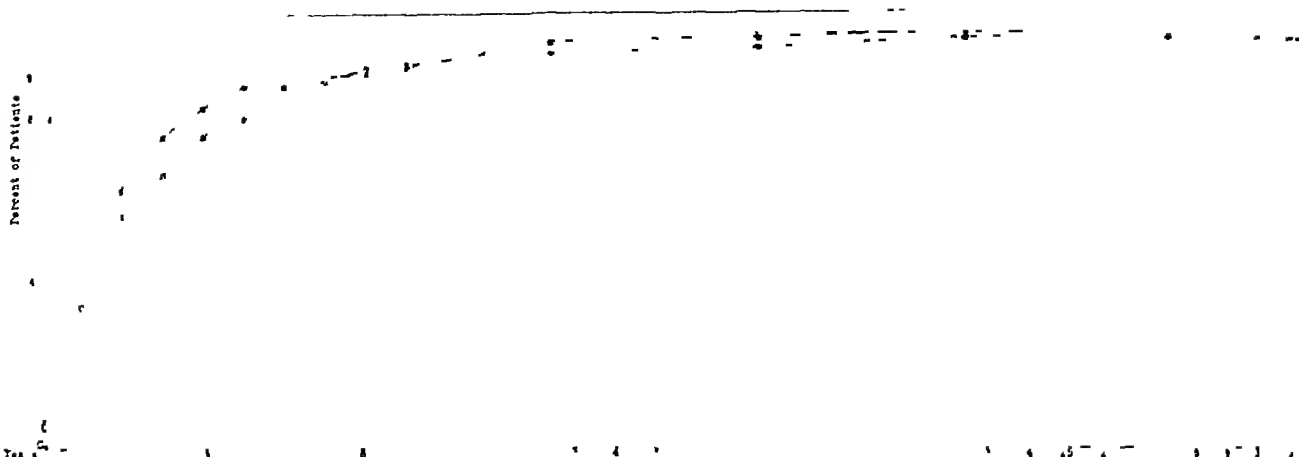
TABLE XXV—*Showing the Number of Patients, the Per Cent Dead and the Per Cent Alive in Various Durations of Life after an Operation for Carcinoma of the Breast, (a) Having Either a Thiersch Graft or Closed Plastic Operation, (b) Without Metastases. All of these Patients Are Known to be Dead*  
*Johns Hopkins Hospital (1889-1931)*

Without metastases						
No of yrs alive after operation	Thiersch graft			Closed plastic		
	No of patients	Per cent dead	Per cent alive	No of patients	Per cent dead	Per cent alive
In hospital	—	—	—	—	—	—
6 months or less	2	5 7	94 3	—	—	—
1 year or less	6	17 1	82 9	—	—	—
2 years or less	9	25 7	74 2	6	31 6	68 4
3 years or less	14	40 0	60 0	10	52 6	47 4
4 years or less	18	51 4	48 6	11	57 9	42 1
5-9 years or less	28	80 0	20 0	14	73 7	26 3
10-14 years or less	30	85 7	14 3	18	94 7	5 3
15-19 years or less	—	—	—	—	—	—
20-24 years or less	33	94 3	5 7	19	100 0	—
25-29 years or less	34	97 1	2 9	—	—	—
30-34 years or less	—	—	—	—	—	—
Unknown	1	2 9	—	—	—	—

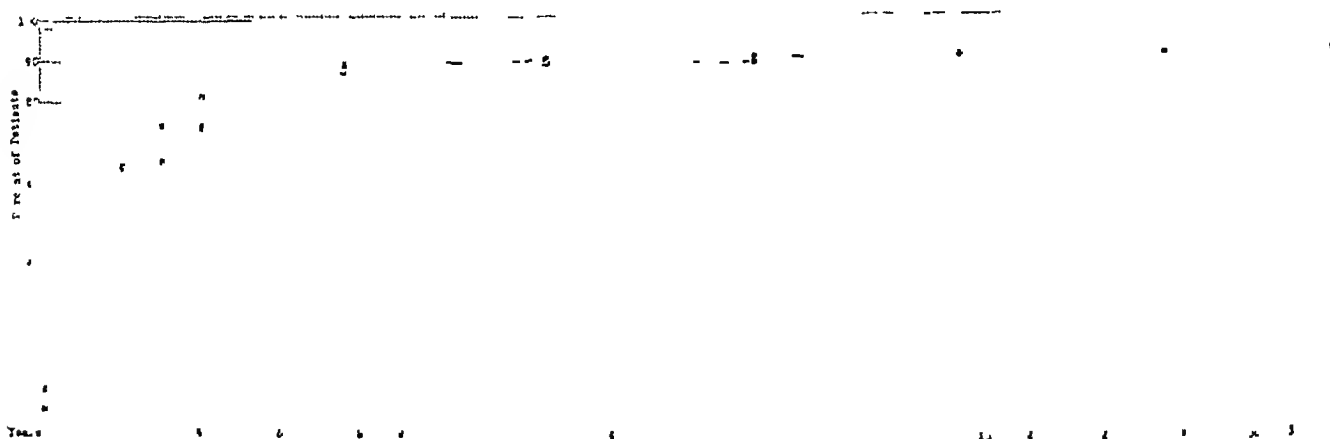
A cumulative table showing the relative merits of the two operative procedures in a group of patients of known dead in whom there were no regional metastases before operation. Attention is called to the fact that in the Thiersch graft group the percentage of patients dying is lower with the exception of the five- to nine-year period than the percentage in the closed plastic.

the closed plastic. This part of Table XXIII should be read from the bottom up. There are more patients living, however, in the closed plastic group, fifty as against forty-seven in the Thiersch graft, but this is due to the fact that the greater number of breast operations since 1925 have been of the closed plastic type, and as yet the patients have not survived the most hazardous earlier years. The cumulative Tables XXIV, XXV and XXVI show the comparative results in better definition. For 326 patients known to be dead in whom there were regional metastases the percentage of deaths in each

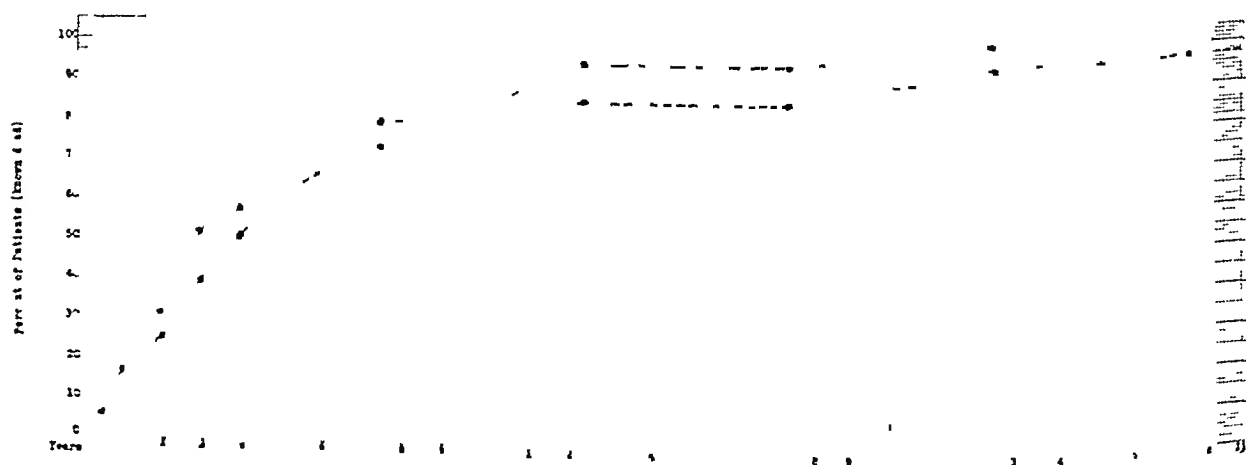




GRAPH H—The percent of patients operated upon by Thiersch graft — — — — — and closed plastic — — — — — carcinoma of the breast who died during the first year, during the first two years, etc \* In hospital Methods for



GRAPH I—A comparison of the percents of those patients who had died by the end of each successive year Thiersch graft — — — — — closed plastic — — — — —, both with metastases \* In hospital



GRAPH II—A comparison of the percent of those patients who had died by the end of each successive year Thiersch graft — — — — — closed plastic — — — — —, both without metastases

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successive year is lower for the Halsted Thiersch graft than the closed plastic group. The same may be said for the series without metastases except for the five- to nine-year period. In the group of those living at present there are forty-seven in the Halsted Thiersch graft group and fifty in the closed plastic group, and in spite of this slight numerical disadvantage there are a greater number of patients living a longer period of years in the Thiersch graft group than in the closed plastic group (Graphs I and J)

TABLE XXVI—*Showing the Number of Patients and the Per Cent Alive in Various Durations of Life after an Operation for Carcinoma of the Breast (a) Having Either a Thiersch Graft or Closed Plastic Operation, (b) With or Without Metastases These Patients Are Known to be Well Johns Hopkins Hospital (1889-1931)*

No of yrs alive after operation	With metastases				Without metastases			
	Thiersch graft		Closed plastic		Thiersch graft		Closed plastic	
	No of pts	Per cent pts	No of pts	Per cent pts	No of pts	Per cent pts	No of pts	Per cent pts
25-29 years	1	4.5	—	—	2	8.0	1	3.8
20-24 years	2	9.1	—	—	6	24.0	1	3.8
15-19 years	7	31.8	1	4.2	8	32.0	5	19.2
10-14 years	10	45.5	3	12.5	12	48.0	8	30.8
5-9 years	15	68.1	10	41.7	23	92.0	17	65.4
4 years	17	77.3	16	66.7	24	96.0	21	80.8
3 years	19	86.4	17	70.8	24	96.0	21	80.8
2 years	21	95.4	17	70.8	25	100.0	22	84.6
1 year	22	100.0	20	83.3	—	—	25	96.2
6 months	—	—	24	100.0	—	—	26	100.0
Totals	22	100.0	24	100.0	25	100.0	26	100.0
	46				51			

There are forty-six patients of the Thiersch graft group living at present and fifty-one of the closed plastic. In spite of this slight numerical disadvantage there are a greater number of the patients living a longer number of years in the Thiersch graft than in the closed plastic. See Graphs I and J.

*An analysis of the operative results in regard to the length of life following operation was made for each year in order to determine whether the efficacy of the operative procedures varied from year to year and also whether the length of post-operative life was shorter when the patients came to operation late in the stage of the disease as they did in the earlier years of the Johns Hopkins Hospital. In Table XXVII is recorded the average*

length of life following operation for the successive years from 1889 until 1931. The average length of life is computed on the basis of the 420 cases of known dead. In the adjoining column the total number of patients is given, but in this tabulation those living and lost to record could obviously not be used. The total number of years that those known to have died still lived was estimated and the average length of life computed by division of this number by the number of deceased. It is to be noted that in 1895, 1898, and 1903 the average length of life was longer than in other years. From 1909 on to date, 1931, the average post-operative length of life begins to decline. Especially is this true for the most recent years, but this is partly due to the fact that a larger percentage of those operated upon previous to 1909 have died and the maximum duration of life in these cases is known. In the earlier years the average length of life is of necessity greater because those patients that have had an opportunity to live a greater number of years and then died have increased the average length of life for the group of those years. The converse explains the shorter average length of life for the groups of the more recent years since 1909. Therefore, from a statistical standpoint, a larger number of cases necessarily dealt with present a more accurate result. With the exception of this general trend downward from 1909 on there is no constant tendency which could be attributed to operative skill. In the earlier years, when practically only the Halsted Thiersch graft operation was used, there is a pronounced fluctuation in the average length of life for the various years in spite of the fact that the duration of life is known in a large percentage of cases. For instance, in 1892, 1893, 1897, 1901 and 1902, the average length of life was quite short regardless of the fact that the treatment and type of operation were exactly the same, and in the majority of cases were in the hands of the same operator, as in the years 1895, 1898, 1899 and 1903, in which the maximum length of life following operation was attained. This would seem to indicate that there will be marked fluctuations in the post-operative results, in spite of the constancy of operative method and individual skill, depending on the type of tumor and the extent of the disease.

*In Table XXVIII the average length of life for patients of the known dead group who were operated upon is shown for each decade.* The first decade, 1890 to 1899, was computed and the average length of life was found to be 4.57 years, which proved to be the same as for the eleven-year period from 1889 to 1899. There was only one additional case for 1889. It is quite interesting to observe that the average length of life from 1889 to 1910 was much greater than from 1910 to the present. As stated, part of this is due to the fact that those operated on between 1889 and 1900 have had an opportunity to live longer, but that does not suffice to explain the rather sudden decline in the average post-operative length of life from 1910 on. For instance in the decade from 1890 to 1899, 68 per cent of the total number of patients had died and the average length of life for this group was 4.57 years. From 1900 to 1909, 53 per cent of the total number of patients had

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TABLE XXVII—Average Length of Life for Known Dead Following Operation for Carcinoma of the Breast for the Successive Years, 1889-1931

Years	No of known dead	No of cases	Length of life X	Total no yrs all lived	Average length of life
1889	2	6	1	4	4 00
1890	5	14		15	3 00
1891	8	11		30	3 75
1892	12	21		34	2 83
1893	7	10		23	3 29
1894	19	24		86½	4 55
1895	16	22	1	97	6 46
1896	17	22		58½	3 44
1897	19	23		53	2 79
1898	22	30		143	6 50
1899	16	27	1	91	6 07
1900	11	21		63½	5 77
1901	17	20	1	46	2 88
1902	16	22		48½	3 03
1903	15	25	1	87	6 21
1904	12	27		49	4 08
1905	13	27	1	56½	4 71
1906	9	20	2	28½	4 07
1907	17	29	2	74½	4 97
1908	12	23	1	48	4 36
1909	12	23		41	3 43
1910	18	23		55	3 06
1911	15	27		43½	2 90
1912	13	22		32	2 46
1913	6	14	1	10½	2 10
1914	13	28		29½	2 27
1915	6	23	1	29	5 08
1916	7	21		21½	3 07
1917	10	25		23	2 30
1918	4	19		11½	2 88
1919	9	29		21	2 33
1920	9	26		37	4 11
1921	5	29		6½	1 3
1922	4	16		3	75
1923	2	22		3	1 50
1924	3	29		13	4 33
1925	3	18		8	2 67
1926	4	28	1	2	67
1927	7	24		12½	1 8
1928	2	21		2	1
1929	1	20		2	2
1930	2	31		Both in hosp	0
1931		8			
Total	420				

The total number of years the known dead lived was estimated and the average length of life computed by division of this number by the number of dead. It is to be noted that in 1895, 1898, 1899 and 1903 the average length of life was larger than in other years. From 1909 on to date, 1931, the average length of post operative life begins to decline. Especially is this true for the most recent years. Undoubtedly this is due to the fact that a lot of those operated upon previous to 1909 have died and the maximum duration of life in these cases is known. The average age of the patient on admission to the hospital from 1889 to 1909 was 49.52 years whereas the average age from 1910 to 1931 is 49.12 years of age.

died with an average length of life of 4.31 years. Thus 15 per cent less had died in this decade and it made a difference in the average length of life for that decade of only .26 of a year. Therefore, the sudden drop in the average length of post-operative life for the decade from 1910 to 1919 of 1.51 years is not likely to be entirely accounted for by the fact that this is a more recent decade, for 43 per cent of the total number of patients have died, making a difference of only 10 per cent between this decade and the

TABLE XXVIII—*Average Post-operative Length of Life of Patients Having Carcinoma of the Breast, by Decades*

*Johns Hopkins Hospital (1889-1931)*

Years	Per cent of patients dead	No of patients dead	Yrs of life after operation	Average length of life after operation (in yrs)
1890-1899	68	138	631	4.57
1889-1899		139	635	4.57
1900-1909	53	126	543	4.31
1910-1919	43	99	277	2.80
1920-1929	17	39	89	2.28
1920-1930	15	41	89	2.17

In the first decade, 1890-1899, the average length of life was found to be 4.57 years which proved to be the same as for the eleven-year period from 1889 to 1899. The average length of life from 1889 to 1910 was greater than from 1910 to the present. This is due to the fact that those operated upon between 1889 and 1900 have had an opportunity to live longer on the average than those operated on since. From 1890 to 1899, 68 per cent of the total number of cases had died and the average length of life for this group was 4.57 years. From 1900 to 1909, 53 per cent of the total number of cases had died with an average length of life of 4.31 years. Thus 15 per cent less had died in this decade which made a difference in the average length of life for that period of .26 of a year. Therefore, the sudden drop in the average length of life for the decade 1910-1919 of 1.51 years in the average length of post-operative life is more likely to be entirely compensated for by the fact that this is a more recent decade, for 43 per cent of the total number of cases have died, making a difference of only 10 per cent between this decade and the previous one, whereas, with a 15 per cent difference existing between the decades 1899 and 1909 was sufficient to account for only a small fraction of a year. In the succeeding decade, 1920-1929, the percentage of patients dying was 17, whereas the average length of life was 2.28 years. With this drop of 26 per cent from the preceding decade the difference in the average length of life was .52 years which suggests that the determinable results from 1920-1929 compare favorably with the decade 1900-1910. The same may be stated for the period 1920-1930.

previous one, whereas a 15 per cent difference existing between the decades 1890-1899, and 1900-1909 was sufficient to account for only a small fraction of one year in post-operative longevity. In the succeeding decade, 1920-1929, the percentage of patients dying was 17, whereas the average length of life was 2.28 years. With this drop of 26 per cent from the preceding

decade the difference in the average length of life was 77 years, which suggests that the determinable results for the decade 1920-1929 compare favorably with those of the decades preceding 1910. The same may be stated for the eleven-year period of 1920 to 1930. Owing to the fact that by the decade 1910-1919 the treatment of carcinoma of the breast was fairly well standardized in the Johns Hopkins Hospital, except for minor variations in the several operators, a variation that persisted in earlier and later decades as well, demonstrates that there is an inevitable fluctuation in the results of the treatment of breast cancer, due, probably, to the type of neoplasm and the indeterminable extent of the disease.

If now one compares the efficacy of the two types of operation from the standpoint of local recurrence, which, after all, is the best criterion of an operative procedure, again the Halsted Thiersch graft operation appears to have the advantage.

If one includes all the cases of carcinoma of the breast which have been operated upon in the Johns Hopkins Hospital, excepting eighteen cases operated upon in 1931 in which there was no follow-up study, it will be noted that this total comes to 750, and includes 420 known dead, 209 lost track of, ninety-seven living and well, of whom 35 per cent have been operated upon less than five years, twenty-four well but having a local recurrence. In these 750 cases there were 144 (19.2 per cent) who had local recurrences. In Table XXIX are computed the number of local recurrences after the different types of operation for patients known to be dead. Of this group of 419 cases local recurrences occurred in 116, 26 per cent of which followed the Halsted Thiersch graft and 34 per cent the closed plastic procedure, a difference of 8 per cent in favor of the former operation. Conversely, 48 per cent of the patients operated upon by the Halsted Thiersch graft method had no local recurrence to compare with 38.7 per cent after the closed plastic type of operation. Thus 9.3 per cent more patients operated upon by the Thiersch graft method had *no* local recurrence and 8 per cent fewer cases had local recurrences by this method. If only the known dead group of 419 cases, concerning which there are accurate data is considered together with twenty-eight patients in whom the presence of a local recurrence was known, we have a total of 447 cases, in which there were 144 instances of local recurrence or 32.2 per cent (Table XXX). A comparison of the operative results in this group discloses the fact that the incidence of local recurrence is 9.6 per cent or approximately 10 per cent less following the Halsted Thiersch graft operation. If the cases with Reverdin grafts were included with the Thiersch graft group the percentage in favor of the latter would be even more pronounced. As a matter of fact, these two groups belong together, for in both a large amount of skin and subcutaneous tissue was sacrificed, differing only in the type of skin graft used to close the remaining skin defect.

*In an effort to determine the effect of local recurrence on the post-operative longevity*, the computations of the average length of life for the

TABLE XXIX —The Number of Local Recurrences, the Number of No Local Recurrences after Operation of Thiersch Graft, Closed Plastic or Reverdin Graft for Carcinoma of the Breast

Type of operation	Local recurrence	No local recurrence	No data	Total No of cases	Per cent of local recurrence	Per cent of no local recurrence	Per cent no data
Thiersch graft	79	146	79	304	26 0	48 0	26 0
Closed plastic	36	41	29	106	34 0	38 7	27 4
Reverdin graft		4		4			
Type unknown	1	1	3	5			
Totals	116	192*	111	419			

\* Of the 192 cases where there was no local recurrence, twenty died in the hospital and one immediately afterwards

Four hundred and nineteen patients of the known dead group were analyzed in this table. One hundred and sixteen had local recurrences, 26 per cent of which recurred after the Thiersch graft and 34 per cent following the closed plastic, a difference of 8 per cent in favor of the Thiersch graft operation. In 192 cases of this group of 419, or 45 8 per cent, there was no local recurrence. Three hundred and four of the 419 cases were operated on by the Thiersch graft and of these 146 or 48 per cent had no local recurrence. The results following the use of the closed plastic procedure were as follows: of 106 cases, in 41 or 38 7 per cent there was no local recurrence. Thus 9 3 per cent more patients operated upon by the Thiersch graft method had no local recurrence and 8 per cent fewer cases had a local recurrence.

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TABLE XXX — *The Number and Per Cent of Local Recurrences after Operations for Carcinoma of the Breast, by the Thiersch Graft, Closed Plastic and Reverdin Graft Methods*

*Johns Hopkins Hospital (1889-1931)*

Type of operation	No of local recurrences	No of operations	Per cent of local recurrences
Thiersch graft	97	322	30.1
Closed plastic	46	116	39.7
Reverdin graft	—	4	—
Type unknown	1	5	20.0
Totals	144	447	32.2

In this table are included not only 419 of the known dead group but 28 patients that are living and have had a local recurrence. The total number of cases in this group comes to 447. 144 or 32.2 per cent had local recurrences. 322 were operated on by the Thiersch graft method and 97 or 30.1 per cent had local recurrences. Of 116 cases, 46 or 39.7 per cent had local recurrences following the closed plastic. This is a difference in the incidence of local recurrence following the two operative procedures of 9.6 per cent or approximately 10 per cent in favor of the Thiersch graft.

group of known dead in Tables XXXI, XXXII and Graph K were compared with the average post-operative longevity for those of the same group in which there was a local recurrence. This comparative analysis revealed a shortening of the average post-operative life in the event of a local recurrence, from 3.62 years' average without to 2.95 years with a recurrence.

TABLE XXXI — *Average Length of Life for Groups of Different Age Incidence, of Patients Operated Upon for Carcinoma of the Breast. Patients Known to be Dead*

Age groups	Total no of yrs of life after oper	No of cases	Average length of life after oper (yrs)
20-24 years	2.0	2	1
25-29 years	15.5	7	2.21
30-34 years	65.0	24	2.71
35-39 years	110.5	47	2.35
40-44 years	179.5	60	2.99
45-49 years	274.0	68	4.03
50-54 years	238.5	57	4.18
55-59 years	146.0	44	3.32
60-64 years	194.0	44	4.41
65-69 years	134.5	27	4.98
70-74 years	39.5	11	3.59
75-79 years	23.0	2	11.50
Totals	1422.0	393	3.62



Peculiarly enough this comes to 0.67 of a year, or about eight months, which is exactly the difference found in the post-operative longevity between the

TABLE XXXII—*Average Length of Life, for Groups of Different Age Incidence, of Patients Operated Upon for Carcinoma of the Breast Patients Known to be Dead*

Age groups	Total no of yrs of life after oper	No of cases	Average length of life after oper (yrs )
20-29 years	17 5	9	1 95
30-39 years	175 5	71	2 47
40-49 years	453 5	128	3 54
50-59 years	384 5	101	3 81
60-69 years	328 5	71	4 63
70-79 years	62 5	13	4 81
Totals	1422 0	393	3 62

See Graph K

two operative procedures for the entire group. If the difference in the average length of life for those with and without a local recurrence is computed for each decade of years in which they were operated upon rather

TABLE XXXIII—*Local Recurrences of Carcinoma of the Breast (Patients Known to be Dead)*

*Johns Hopkins Hospital (1889-1931)*

Decades	No of cases of recurrences	No of cases	Per cent of recur- rences	Total length of life (yrs ) after local recurrences	Average length of life after local recur- rences
1889		2	—	—	—
1890-1899	49	141	34 8	141 5	2 89 years
1900-1909	35	134	26 1	107 0	3 45 years
1910-1919	27	101	26 7	73 0	2 70 years
1920-1929	5	40	12 5	8 5	1 70 years
1930-1931	—	2	—	—	—
Totals	116	420		330 0	2 95 years

Difference in the average length of life of patients with and without recurrence is 3.62 years minus 2.95, or 0.67 of a year. If, however, the earlier decades are used concerning which we have from a statistical standpoint more accurate data, there is a difference of 1.68 years in the longevity of those having and not having a recurrence. Compare Tables XXVIII and XXXIII.

than the decade in reference to their age, it is at once apparent that there is a difference of 1.68 years for the decade ending in 1899. In other words, those patients operated upon between 1889 and 1899 that developed a local

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TABLE XXXIV — *Frequency Distribution, According to Age (Ten-Year Grouping) of 116 Cases of Carcinoma of the Breast, Where There Was a Local Recurrence*  
*Johns Hopkins Hospital (1889-1931)*

Age in yrs	Cases of carcinoma of breast, age of incidence	Local recurrences, carcinoma of breast	Per cent of cases having local recurrences
20-29	9	6	66 7
30-39	75	31	41 3
40-49	134	30	22 4
50-59	110	26	23 6
60-69	77	19	24 7
70-79	14	3	21 4
Unknown	1	1	—
Totals	420	116	

On the whole the younger the patient is the more susceptible to local recurrence

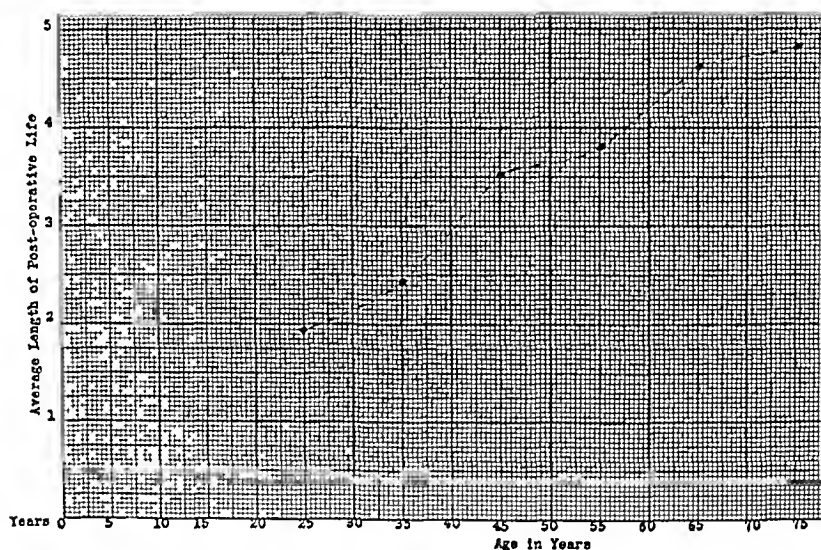
TABLE XXXV — *The Situation of Local Recurrences after Thiersch Graft and Closed Plastic Operations for Carcinoma of the Breast*  
*Johns Hopkins Hospital (1889-1931)*

Thiersch graft			Closed plastic		
Site of local recurrences	No of local recurrences	Per cent of local recurrences	Site of local recurrences	No of local recurrences	Per cent of local recurrences
A	2	2 1	E	2	4 3
I	13	13 4	B	21	45 7
CDHI	1	1 0	BJ	5	10 9
CDH	53	54 6	J	2	4 3
ACDH	8	8 2	BGEF	1	2 2
C	3	3 1	GEF	1	2 2
CD	3	3 1	GEJ	1	2 2
DH	2	2 1	BG	5	10 9
			BE	1	2 2
			G	1	2 2
			GF	1	2 2
Unknown	12	12 4	Unknown	5	10 9
Total	97	100 0		46	100 2

In one case where there was a local recurrence, the data concerning the type of operation were not given, therefore there were 144 local recurrences

See Bar Diagrams L and M The great majority of local recurrences involve the skin, particularly is this true of the closed plastic Therefore, more skin should be removed

recurrence lived 168 years less than those patients in whom there were no local recurrences. This difference diminishes, as seen by a comparison of Tables XXVIII and XXXIII, in the later or more recent decades because there is a larger percentage of those with local recurrences that have died, for these patients die sooner after operation. This, together with the fact that more patients are still living in these decades and therefore their post-operative longevity cannot be determined, accounts for the shorter average length of life so far computed for the decade and a closer approach to the average length of life of those having a local recurrence. In future years when those whose post-operative life is destined to be long have been given a sufficient number of years to have completed their life, the average length of post-operative life of those not having a recurrence will as in the earlier years increase the average for that particular decade. The more recent the



GRAPH K—Age in years. Average length of life after operation of patients having carcinoma of the breast (Patients known to be dead)

decade the more closely the averages for those having or not having a local recurrence will approximate each other. The converse seems also to be true, *i.e.*, the earlier or more remote the decade the more divergent will be these averages.

The data as to the presence or absence of a local recurrence which can be seen by the patient, family, and attending physician are apt to be far more accurate than the information regarding metastases or other causes of death. At the same time, it is the best criterion of the efficacy of an operative procedure. If the disease has been cured locally the operator has fulfilled his responsibility.

*The effect of age on the probability of a local recurrence* is shown in Table XXXIV, which demonstrates the increased likelihood of a local recurrence in the younger patient and *vice versa*.

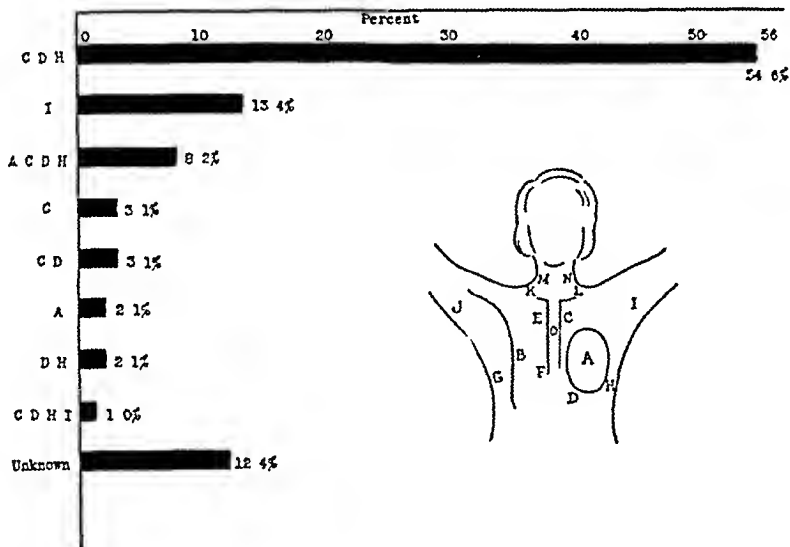
Further evidence of the advisability of sacrificing the largest possible area of skin is supplied when the *location of the recurrences are considered*

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(Table XXXV, Bar Diagrams L and M) The large majority of the local recurrences following the closed plastic procedure occurred along the incision.

BAR DIAGRAM L

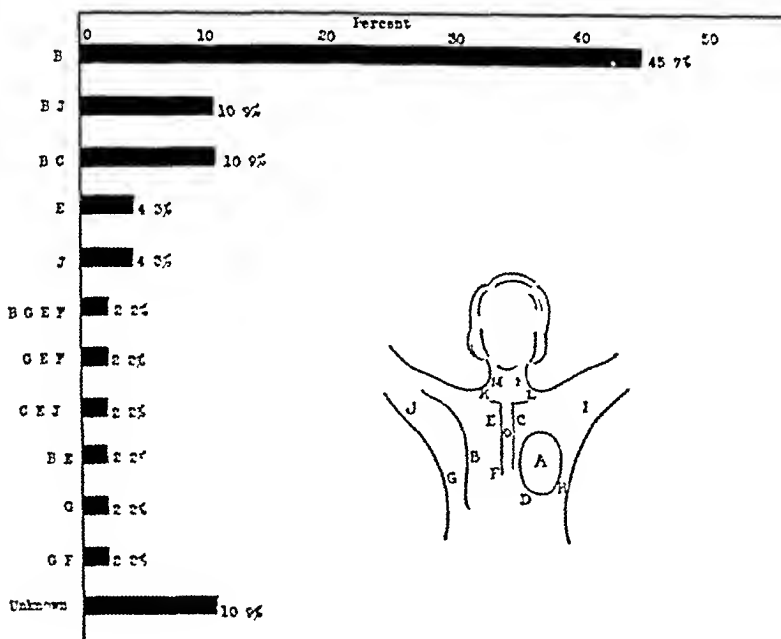
*The Situation of Local Recurrences after a Thiersch Graft Operation for Carcinoma of the Breast  
Johns Hopkins Hospital (1889-1931)*



in the skin and subcutaneous tissue, where there was no evidence of carcinoma before operation. However, whether these regional metastases in the skin and subcutaneous tissue, or extensions from the primary tumor were

BAR DIAGRAM M

*The Situation of Local Recurrences after a Closed Plastic Operation for Carcinoma of the Breast  
Johns Hopkins Hospital (1889-1931)*



present before operation but clinically were unrecognized, or whether they were remoculations at the time of operation it matters not for the only manner in which they can be prevented is by avoiding the primary tumor by a wider margin and removing a greater amount of skin and subcutaneous

tissue in the immediate environment. In the Thiersch graft operation there were also some tumors that recurred in the skin about the periphery of the grafted area but the great majority seem to be deep beneath the skin, arising in the chest-wall and later involving the surface. These probably began either in the lymphatic vessels along the course of the anterior perforating branches of the internal mammary artery or in the slips of origin of the pectoralis major muscle. However, it is questionable whether local recurrences in these deep situations could be prevented by a more careful dissection coupled with some form of mild cauterization. Probably the incidence of local recurrence in the Thiersch graft group could have been reduced even more, had a greater amount of skin and subcutaneous tissue been removed. At least this seems probable in some cases of this group in which there were eventually local recurrences in the skin about the grafted area. For when the fact that the breast is an appendage of the skin is taken into consideration, is it not logical that the adjacent skin in the region of the primary tumor would be the most likely site of recurrence? Therefore, it would seem that the removal of a large area of skin is just as important, if not more so, as that of the subcutaneous tissue or underlying muscles. Certainly in this series by far the larger percentage of recurrences took place in the skin and subcutaneous tissue immediately underlying it. It would therefore appear to us to be paradoxical to make the incision close to the tumor in the skin and superficial subcutaneous tissue and excise widely the deep fascial layers and muscle beneath, but just as much so than the converse procedure. It is, of course, not practical to consider the removal of the skin commensurate with the wide excision of subcutaneous tissue and deeper structures, or, in other words, equal to the limits of the operative field. This would mean denuding the chest-wall. But it does seem that the larger the amount of skin removed the less the chance of local recurrence, the greater the probability of survival over the first perilous five years and a definite increase in post-operative longevity. Therefore, very large areas of skin should be removed regardless of the size or position of the tumor, whether deep in the breast or superficial, leaving the closure of the defect out of mind until the end of the operation. No matter how large the defect, it may be closed immediately by Thiersch or later by Reverdin grafts. In unusual cases it is occasionally possible to close without grafting, but the plastic incision should certainly be planned after the operation is finished and not in the beginning. The superiority of the results of the Thiersch graft group in this series of cases lies wholly in the wide excision of the skin. It is not probable that the presence of a graft is of any importance in the prevention of a recurrence. The operator, after removing more skin than he feels necessary with every point in the incision equidistant from the tumor, may, after completing the operation and obliterating the dead space in the axilla without tension, close as he can with the skin flaps that remain. The manner from the standpoint of curing the disease is inconsequential. If there is, and except in unusual cases there will be, a defect it may be grafted, but it would appear to be the defect, not the

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graft, that tends to prevent a local recurrence. The sloughing of the skin flaps, while rather unsurgical, following some plastic operations would appear to be a fortunate intervention for the patient. Therefore, if an operative procedure be selected on the basis of the lower percentage of local recurrences, the slight but definite increased post-operative longevity, and the fact that a greater percentage of patients will survive the first five years then the preference for the Halsted Thiersch graft operation or a procedure of this type in which a large amount of skin is excised, is indisputable.

When the percentage of local recurrence was considered from the standpoint of the pathological variety of the tumor (Table XXXVI), it was found

TABLE XXXVI—*Local Recurrences after Thiersch Graft and Closed Plastic Operations, for Carcinoma of the Breast, Classified as to Type of Tumor*  
*Johns Hopkins Hospital (1889-1931)*

Type of tumor	Thiersch Graft			Closed Plastic		
	No of operations	No of local recurrences	Per cent of local recurrences	No of operations	No of local recurrences	Per cent of local recurrences
Scirrhus	217	72	33.2	79	29	36.7
Medullary	64	14	21.9	21	6	28.6
Adeno	28	6	21.4	7	4	57.1
Colloid	4	—	—	1	1	100.0
Cancer in cyst	2	2	100.0	1	1	100.0
Comedo	1	—	—	—	—	—
Paget's	1	—	—	—	—	—
Carcinoma	2	1	50.0	3	3	100.0
Spinal cell	1	—	—	—	—	—
Colloid adeno	1	—	—	—	—	—
Sarcoma	1	1	100.0	1	—	—
Intracystic papilloma	1	1	100.0	—	—	—
Unknown	1	—	—	4	2	50.0
Totals	324	97		117	46	

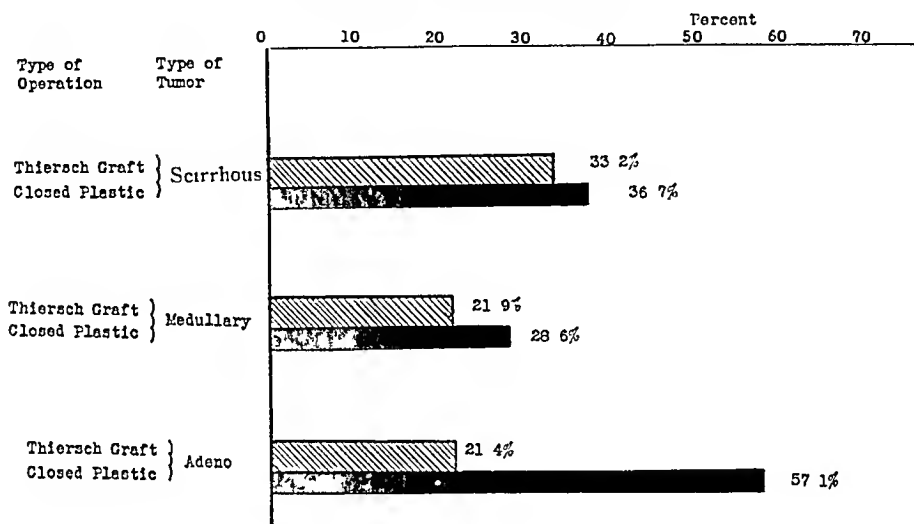
Four hundred and forty-one cases comprising the group of known dead and living with a recurrence. See Bar Diagram N.

that the highest percentage occurred with scirrhus, with adeno-carcinoma, and medullary cancer, in the order named. When the type of tumor is considered in conjunction with the method of operation the results can be seen in Bar Diagram N. With each type of tumor the percentage of local recurrence is less with the Thiersch graft procedure.

In Table XXXVII an attempt has been made to establish a relation between the duration of the tumor before operation and the length of life afterward, in the group of patients known to have died. From this table the average length of life for several periods of disease duration was calculated and it was found that with a duration of three months the average length of

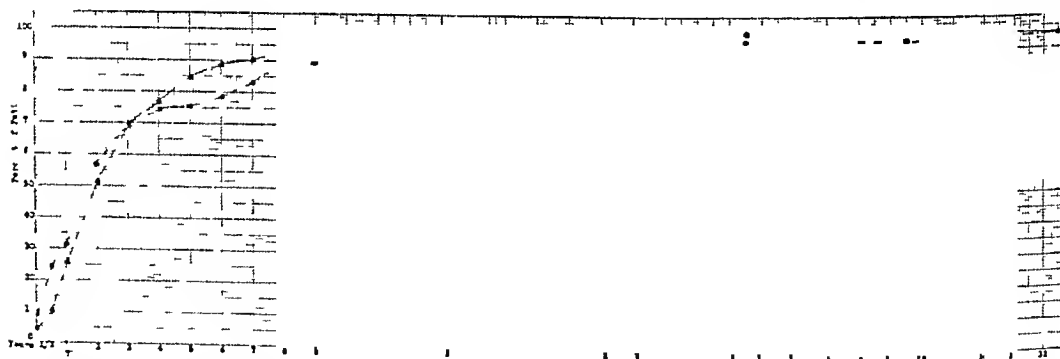
life was 3 87 years, for six months, 2 86 years, for nine months, 3 07 years, for one year, 2 57 years, for two years, 3 54 years, for three years, 3 65 years, for four years, 4 91 years. It would seem that although there is con-

BAR DIAGRAM N  
The Percent of Local Recurrences after Thiersch Graft and Closed Plastic Operations  
Classified as to Type of Tumor



The black bars represent the results following the closed plastic procedure for the various types of tumors, whereas the light shaded ones represent the results following the Thiersch

siderable inconstancy in the comparison between pre-operative duration of the tumor and the post-operative length of life up to one year's duration, certainly after one year, the longer the duration of the tumor before operation the longer the life of the patient after the onset. This might be concluded



GRAPH O—The percent of patients that had died by the end of each successive year, for the cases where the duration of the tumor before operation was three months or less and where it was more than one year but not greater than two years. Three months ————— Two years - - - - - \* In hospital

from the average length of post-operative life for groups in which the tumors were of varying pre-operative duration. This is probably due in a large measure to the fact that slow-growing tumors are of longer duration so far as the patient's knowledge goes. This is only apparent. When, however, one studies Table XXXVII, it will be noted that there are two out-

Table XXXVII—Four Hundred and Twenty Cases of Carcinoma of the Breast Patients Known Dead Duration of Carcinoma Prior to Operation

Time	Duration of Carcinoma Prior to Operation												
	Unknown	3 mos	6 mos	9 mos	1 yr	2 yrs	3 yrs	4 yrs	5-9 yrs	10-19 yrs	20-29 yrs	30 yrs and over	Total
Unknown	1	4	4	3	3	6	4	1	1				27
In hospital 6 months	1	6	5	3	3	3	2	1	1				25
1st year		10	4	11	8	5	1	1	1				44
2nd year		5	11	15	11	2	1	1	1				56
3rd year		17	23	10	15	19	6	3	4				98
4th year	2	8	5	8	7	13	1	1	1				44
5th year		3	6	3	6	6	5	2	2				56
6th year		1	3	6	6	6	1	2	2				44
7th year		1	3	1	6	6	1	1	1				44
8th year		2	3	1	2	6	5	1	2				56
9th year		3	2	3	2	6	1	1	2				56
10th-14th year		4	1	3	5	3	3	3	1				98
15th-19th year		2	3	1	1	1	2	1	1				44
20th-24th year		2	3	1	1	2	2	2	1				37
25th-29th year		2	1	1	2	1	1	1	1				16
30th-34th year		3	1	1	2	1	1	1	1				16
Totals													623
Total No of years	4	70	71	53	69	80	24	17	16	8	5	3	420
Average length of post-oper life, years	271	203	162.5	177	283.5	87.5	83.5						2
	3.87	2.86	3.07	2.57	3.54	3.65	4.91						1

With a duration of three months the average length of life is 3.87 years. Six months, 2.86 years, nine months, 3.07 years, one year, 2.57 years, two years, 3.54 years, etc. There are two main groups, however, one in which the duration of the growth was three months or less and that group in which the duration was between one and two years but no more than two. The group of three months or less comprised sixty-six patients, and the two-year one seventy-four cases. This portion of Table XXXVII was then placed in cumulative form in Table XXXVIII.



standing groups of approximately the same size but of marked divergence as to the duration of the tumor before operation, *i e*, the group in which the duration of the growth was three months or less and two years, the latter group including all cases of more than one, but no more than two years' duration. The group of three months' duration comprised sixty-six patients and the two-year group seventy-four cases. This portion of Table XXXVII

TABLE XXXVIII—*The Per Cent of Patients That Had Died by the End of Each Successive Year, for the Cases Where the Duration of the Tumor before Operation was Three Months or Less, and Where It Was More than One Year but Was Not Greater than Two Years*

*Johns Hopkins Hospital (1889-1931)*

Length of post oper life	Duration of tumor before oper	
	3 mos Per cent of patients	1-2 yrs Per cent of patients
In hospital	9 1	4 1
6 months or less	24 2	10 8
1 year or less	31 8	25 7
2 years or less	57 6	51 4
3 years or less	69 7	68 9
4 years or less	74 2	77 0
5 years or less	75 8	85 1
6 years or less	78 8	89 2
7 years or less	83 3	90 5
8 years or less	89 4	93 2
9 years or less	89 4	94 6
10-14 years or less	92 4	97 3
15-19 years or less	95 5	97 3
20-24 years or less	100 0	97 3
25-29 years or less	—	97 3
30-34 years or less	—	100 0

Graph O. This table and curve demonstrate that of those patients coming into the hospital within three months of discovery of the tumor a greater percentage die in each successive year up to the third year than of those of the two-year duration group. After three years, however, a complete reversal occurs and a smaller percentage of the three months' group die each succeeding year than the two-year group, indicating that in spite of the most radical operation in some of the patients comprising the three months' group there had occurred already metastases beyond the limits of the operative field. On the average, however, it shows that the earlier the case is presented for surgical therapy the more likelihood of the disease being a localized one.

was then placed in cumulative form (Table XXXVIII), and the results plotted in Graph O. This table and curve demonstrate that of those patients coming into the hospital within three months of the discovery of the tumor a greater percentage die in each successive year up to the third year than of those of the two-year duration group. After three years, however, a complete reversal occurs and a smaller percentage of the three-months group dies each succeeding year than of the two-year group. This would indicate that

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TABLE XXXIX—Ninety-seven Cases of Carcinoma of the Breast, Patients Reported 11 All Duration of Carcinoma of the Breast Prior to Operation

	Unknown	3 mos	6 mos	9 mos	1 yr	2 yrs	3 yrs	4 yrs	5 yrs	6-10 yrs	10 yrs	Total
Unknown												
In hospital												
6 months												
1 year												
2 years		2										5*
3 years		4										7*
4 years			1		1							1
5 years		1			1							3
6 years		4			2							13*
7 years		7			2			1				12*
8 years												
9 years		2										
10-14 years	1	1	4		1			1		1		9*
15-19 years	1											3
20-24 years		2			1							13*
25-29 years		6						1		2		12*
Total	2	29	22	7	11	9	3	7	3	3	1	97
Totals for the years*												381

In Table XXXIX the relation of the duration of the tumor before operation and the longevity for the group of patients now living was estimated and there is a lack of definite tendency, but one striking feature is that over one-half of those now living were operated upon within six months of the onset

It is impossible in this group to work the average length of life because they are still living

although a radical operation was performed very early in the duration of the disease in that group of patients comprising the three-months group a certain percentage, owing to the type of tumor and rapidity of growth, had already metastasized beyond the limits of operability. In the remainder of this group the carcinoma was yet confined within operative limits and these patients surviving the three-year period lived longer. The converse may be said concerning members of the group in which the duration of the lesion was two years and who did not die as rapidly as those of the other group and indicates the relative slow growth of the tumor. After the three-year period the death rate in this group is higher per year, a fact which appeared to be due to extension of the carcinoma to other parts. The duration, therefore, is important from the standpoint of prognosis, because undoubtedly the post-operative longevity of the two-year group could have been increased if they had submitted to a radical operation earlier in the course of the disease. On the other hand, in spite of the early treatment in the three-months or less group a large percentage die with metastases within three years. Thus the type of tumor from a histological as well as a biological standpoint plays in our present state of knowledge an indeterminable rôle.

In Table XXXIX the relation of *the duration of the tumor before operation and the longevity for the group of patients now living* was estimated and there was found to be a lack of definite tendency, but one striking feature is that over one-half of those now living were operated upon within six months of onset. It is impossible in this group to establish the average length of life because they are still living.

*A study of the length of life after operation in connection with the type of tumor was made of the 420 patients known to be dead.* This computation is tabulated in Table XL. It is to be noted that of the three main types of carcinoma of the breast encountered in the study, *i e*, scirrhus, medullary and adeno-carcinoma, the post-operative length of life of the patients suffering from medullary carcinoma was on the whole shorter than that of the patients having scirrhus or adeno-carcinoma. The latter, on the average, while fewer in number, lived longer than either of the former. This table gives the absolute number of patients who died each successive year together with the percentage of the whole of each separate group. Table XLI shows the material of Table XL in cumulative form, and demonstrates the same points referred to under Table XL. The calculations for the first ten years are the most interesting because following this period the remaining cases are few and scattered, and by this time 90 per cent of the patients have died. At the end of two years 53.9 per cent of scirrhus, 59.3 per cent of medullary, and only 21.9 per cent of adeno-carcinoma patients were dead. By the end of five years about three-fourths of the scirrhus and medullary but only three-fifths of the adeno-carcinoma patients were dead. The isolated cases of other and various types of carcinomata, shown in Table XL, were considered too few to include in Table XLI.

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TABLE XL.—*Carcinoma of the Breast Length of Post-Operative Life with Type of Tumor, 120 Cases*

Length of life	Scirrhous		Medullary		Adeno		Simple carc	Sarcoma	Paget's Cancer	Colo- myst	Colo- loid	Squid cell	Colo- loid adeno	Colo- mado	N
	No	Per cent	No	Per cent	No	Per cent									
In hospital	9	3.2	7	8.6	2	6.3								1	1
6 months	36	12.7	6	7.4	3	9.4	2								
1 year	39	13.7	18	22.2	3	6.3	3								
2 years	69	24.3	17	21.0	2	6.3									
3 years	28	9.9	9	11.1	8	25.0									
4 years	28	9.9	5	6.2	2	6.3									
5 years	13	4.6	1	1.2	2	6.3									
6 years	13	4.6	6	7.4	1	3.1									
7 years	12	4.2			3	9.4									
8 years	6	2.1	3	3.7	1	3.1									
9 years	2	1.7	1	1.2											
10 years	4	1.4	2	2.5											
11 years	2	1.7	1	1.2											
12 years	2	1.7			1	3.1									
13 years	1	1.4			1	3.1									
14 years															
15 years	1	1.4	2	2.5	1	3.1									
16 years			1	1.2											
17 years															
18 years					1	3.1									
19 years															
20 years	1	1.4													
21 years	2	2.1													
22 years	1	1.4													
23 years	2	2.1													
24 years					1	3.1									
25 years	1	1.4													
26 years	1	1.4			1	3.1									
27 years	1	1.4													
28 years	1	1.4			2	6.3									
29 years	1	1.4													
Totals	284	100.8	81	99.8	32	100.1	6	1	1	3	4	1	1	1	5

It is to be noted that the post-operative length of life of those patients affected with medullary carcinoma was on the whole shorter than that of the patients having scirrhous or adeno-carcinoma. The latter lived longer than either of the former. This table gives the absolute number of cases, having died each successive year together with the percentage of the whole of each separate group.

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TABLE XLI —Length of Life after Operation for Carcinoma of the Breast with Type of Tumor  
Four Hundred and Twenty Cases Known Dead Cumulative

Johns Hopkins Hospital (1889-1931)

Length of life	Scirrhus		Medullary		Adeno	
	No of cases	Per cent cases	No of cases	Per cent cases	No of cases	Per cent cases
In hospital	9	3 2	7	8 6	2	6 3
6 months or less	45	15 8	13	16 0	2	6 3
1 year or less	84	29 6	31	38 3	5	15 6
2 years or less	153	53 9	48	59 3	7	21 9
3 years or less	181	63 7	57	70 4	15	46 9
4 years or less	209	73 6	62	76 5	17	53 1
5 years or less	222	78 2	63	77 8	19	59 4
6 years or less	235	82 7	69	85 2	20	62 5
7 years or less	247	87 0	72	88 9	23	71 9
8 years or less	253	89 1	72	88 9	24	75 0
9 years or less	255	89 8	73	90 1	25	78 1
10 years or less	259	91 2	75	92 6	25	78 1
11 years or less	261	91 9	76	93 8	25	78 1
12 years or less	263	92 6	78	96 3	25	78 1
13 years or less	264	93 0	78	96 3	26	81 3
14 years or less	264	93 0	78	96 3	27	84 4
15 years or less	265	93 3	78	96 3	27	84 4
16 years or less	266	93 7	79	97 5	28	87 5
17 years or less	—	—	—	—	—	—
19 years or less	266	93 7	80	98 8	28	87 5
20 years or less	266	93 7	80	98 8	29	90 6
21 years or less	268	94 0	80	98 8	29	90 6
22 years or less	270	95 1	80	98 8	29	90 6
23 years or less	271	95 4	80	98 8	29	90 6
24 years or less	272	95 8	80	98 8	29	90 6
25 years or less	272	95 8	80	98 8	29	90 6
28 years or less	273	96 1	80	98 8	30	93 8
32 years or less	273	96 1	80	98 8	30	93 8
Unknown	11	3 9	1	1 2	2	6 3
Totals	284	100 0	81	100 0	32	100 1

Shows the material of Table XL in cumulative form. The calculations for the first ten years are most interesting because following this period the remaining cases are few and scattered and by this time 90 per cent of the cases have died. At the end of two years 53.9 per cent of scirrhus, 59.3 per cent of medullary, and only 21.9 per cent of adeno-carcinoma were dead. By the end of five years about three-fourths of scirrhus and medullary, but only three-fifths of adeno-carcinoma were dead. The few isolated cases of other and various types of carcinomata, shown in Table XL, were considered too few to include in Table XLI.

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*The average length of life following operation for carcinoma of the breast for patients known to be dead was computed with reference to the age of the*

TABLE XLII—*Complete Expectation of Life in Years, 1919-1920, for White Females*

Exact age in yrs	E <sub>x</sub> <sup>o</sup>
0	57 52
1	60 63
2	60 60
7	57 05
12	52 62
17	48 22
22	44 21
27	40 46
32	36 77
37	32 99
42	29 11
47	25 21
52	21 43
57	17 84
62	14 50
67	11 49
72	8 92
77	6 77
82	5 08
87	3 76
92	2 62

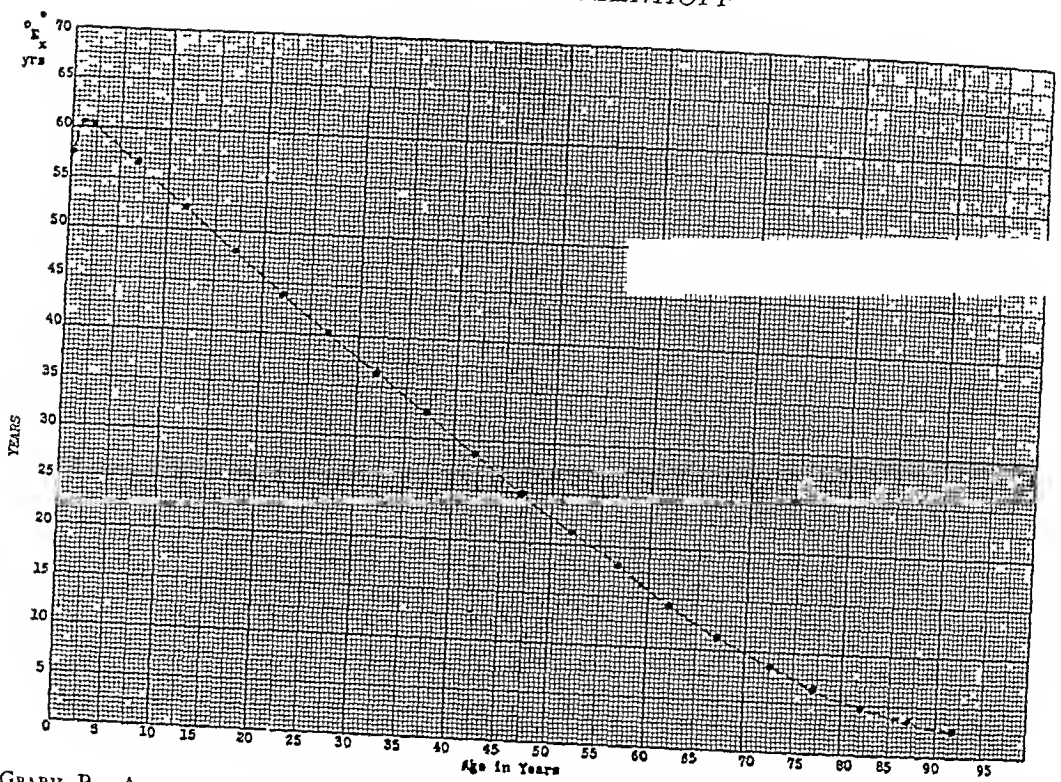
From U. S. Abridged Life Table, 1919-1920 (pp. 26-27)

In Aggregate—New England States, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Tennessee, Kentucky, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Missouri, Kansas, Utah, California, Oregon, Washington

The average length of life following operation for carcinoma of the breast for patients known to be dead was computed with reference to the age of the patient at the time of operation. This computation is shown in Table XXXI wherein the average post-operative length of life is charted in five-year groups. In a distribution of normal individuals the life expectancy would be greatest for the group from twenty to twenty-four and diminishes for each successive year as shown in this Table XLII, Graph P, whereas in the group of individuals affected with carcinoma the average length of life is least in the earlier pentades, Table XXXI, beginning with twenty to twenty-four years and increased successively, except the periods thirty-five to thirty-nine and fifty-five to fifty-nine, until the seventieth year. The decline following this period of life might readily be explained by the diseases of old age. An inexplicable drop occurs for the age group fifty-five to fifty-nine. The average post-operative length of life increases in the cases affected with carcinoma with the advance in the age of incidence. Graphically demonstrated in Graph K. This shows conclusively that the older the patients at the time of operation the greater the life expectancy following operation.

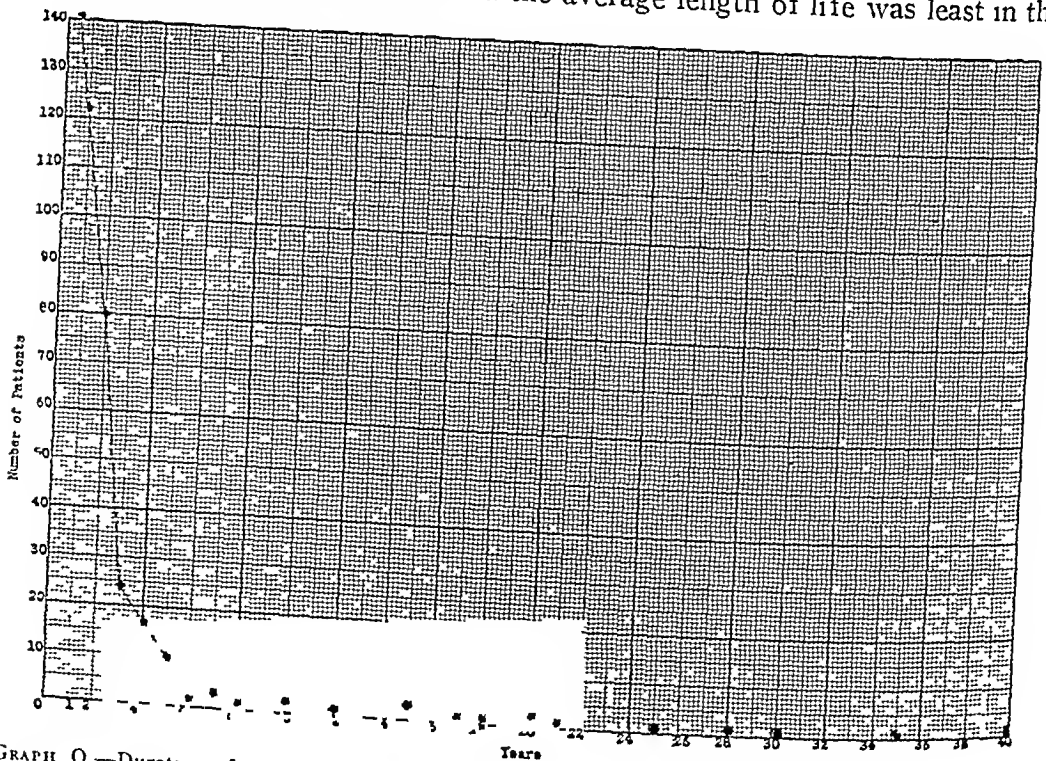
*patient at the time of operation.* This computation is shown in Table XXXI wherein the average post-operative length of life is charted in five-year groups.

In a distribution of normal individuals the life expectancy would be great-



GRAPH P—Age in years Showing the complete expectation of life in years, 1919-1920, for white females  ${}^{\circ}E_x$ —Expectation of life

est for the group from twenty to twenty-four and diminishes for each successive year as shown in Table XLII and Graph P, whereas in the group of individuals affected with carcinoma the average length of life was least in the



GRAPH Q—Duration of carcinoma of breast from onset of disease to operation, 416 cases (dead)

## CANCER OF THE BREAST

earlier pentades (Table XXXI), beginning with twenty to twenty-four years, and increased successively, excepting the periods thirty-five to thirty-nine, and fifty-five to fifty-nine, until the seventieth year. The decline following this period of life might readily be explained by the diseases of old age. An inexplicable drop in the average length of life occurs for the age group fifty-five to fifty-nine. In Table XXXII is shown the average length of life of

TABLE XLIII — *The Duration of the Tumor from Onset to Operation for 420 Patients Having Carcinoma of the Breast*

*Johns Hopkins Hospital (1889-1931)*

Time duration from onset to operation	Absolute no of cases	Per cent of cases	Cumulative no of cases	Per cent of cumulative cases
6 months	141	33.6	141	33.6
1 year	122	29.0	263	62.6
2 years	80	19.0	343	81.7
3 years	24	5.7	367	87.4
4 years	17	4.0	384	91.4
5 years	10	2.4	394	93.8
6 years	2	.5	396	94.3
7 years	3	.7	399	95.0
8 years	1	.2	400	95.2
9 years	—	—	—	—
10-14 years	3	.7	403	96.0
15-19 years	5	1.2	408	97.1
20-24 years	3	.7	411	97.9
25-29 years	2	.5	413	98.3
30-34 years	1	.2	414	98.6
35-39 years	1	.2	415	98.8
40-44 years	1	.2	416	99.0
Unknown	4	1.0	4	1.0
Totals	420		420	100.0

Four cases of the group of 420 known dead could not be used because the histories were incomplete. See Graph Q. This table gives the absolute number of cases for six months and then the yearly periods after that, as well as the percentages of these respective periods. Also, the cumulative number of cases with their percentage is shown. It is to be noted that 33.6 per cent of the patients had come in for examination within six months of the discovery of the tumor and 62.6 per cent within the first year. More than four-fifths or 81.7 per cent of these cases had consulted this hospital by the second year.

patients operated upon, the age of incidence being given in ten-year groups instead of five. This table demonstrates, as does Table XXXI, but without the minor fluctuations that the average post-operative length of life increases with the advance in the age of incidence. This is demonstrated in Graph K and shows conclusively that the older the patient at the time of operation the greater the life expectancy following operation.



The duration of the disease from the time the patient first recognized the affection until operation was performed has been computed for the known dead, *i e*, for 420 cases with the exception of four in which the history was incomplete. This computation is shown in Table XLIII and Graph Q. This table gives the absolute number of cases for six months and then the yearly

TABLE XLIV—*The Absolute Number of Patients for Various Durations of Life from the Onset of Carcinoma of the Breast until Death (392 Patients Known Dead)\**

*Johns Hopkins Hospital (1889-1931)*

Duration of life from onset of disease until death	Absolute no of cases	Per cent of cases	Cumula- tive	Per cent dead	Per cent alive
6 months or less	11	2.8	11	2.8	97.2
1 year	45	11.5	56	14.3	85.7
2 years	70	17.9	126	32.1	67.9
3 years	68	17.3	194	49.5	50.5
4 years	39	9.9	233	59.4	40.6
5 years	38	9.7	271	69.1	30.9
6 years	18	4.6	289	73.7	26.3
7 years	28	7.1	317	80.9	19.1
8 years	11	2.8	328	83.7	16.3
9 years	10	2.6	338	86.2	13.8
10-14 years	20	5.1	358	91.3	8.7
15-19 years	14	3.6	372	94.9	5.1
20-24 years	8	2.3	380	96.9	3.1
25-29 years	6	1.5	386	98.5	1.5
30-34 years	4	1.0	390	99.5	.5
35-39 years	1	.3	391	99.7	.3
40-44 years	1	.3	392	100.0	0
Totals	392	100.0	392	100.0	0

\* In 28 cases there was insufficient data.

See Graph R. The actual number of cases which succumbed in various periods together with their percentage. Eleven or 2.8 per cent died within six months and forty-five or 11.5 per cent within six months and the first year. The cumulative column, however, shows the total number of cases dealt with in which the length of life is known, 392, and of these eleven died within the first six months. Therefore 381, or 97.2 per cent lived more than six months, *etc*. It will be noted that the greater number of deaths occurred in the first, second, and third years. The cumulative column demonstrates the number of people alive for the successive years, which is objectively shown in Graph S.

periods after that, as well as the percentages of these respective periods. Also, the cumulative number of cases with their percentage is shown. It is to be noted that 33.6 per cent of the patients had come in for examination within six months of the discovery of the tumor and 62.6 per cent within the first year. More than four-fifths of all these patients (81.7 per cent) had consulted this hospital by the second year. This tendency is shown in Graph G. (The points on the graph which are not joined by the curve represent isolated



instances in which the duration from a charting standpoint was disconnected from the preceding period )

In Table XLIV an analysis has been made of the duration of life in 420 cases of known dead from the time the patient first noticed the disease until death after operation. It has been necessary to exclude from this group twenty-eight cases because one factor has been unknown, thus 392 remained. In Table XLIV and Graph R the actual number of patients who succumbed in the various periods is shown together with their percentage. In this chart it will be noted that eleven patients (2.8 per cent) died within six months, and forty-five (11.5 per cent) within six months and the first year. The cumulative column, however, shows the total number of cases dealt with in

TABLE XLV — *The Age Distribution and Per Cent of Patients, Operated Upon for Carcinoma of the Breast, Who Lived Ten Years or More*

*Johns Hopkins Hospital (1889-1931)*

Age in yrs	No of patients	No of patients who lived 10 yrs or more	Per cent of pa- tients who lived 10 yrs or more
30-39 years	109	13	11.9
40-49 years	192	20	10.4
50-59 years	159	21	13.2
60-69 years	94	12	12.7
70-79 years	19	5	26.3
Totals	573	71	12.2

Total number of possible cases 573, which number included the known dead and all cases living operated on prior to 1921 with the exception of those concerning whom there was no knowledge as to the length of life after operation. Seventy-one or 12.2 per cent of these cases lived ten years or more. The percentage of patients living ten years or more for each age group with the exception of seventy to seventy-nine was practically the same, varying from 10.4 per cent to 13.2 per cent.

which the length of life is known, 392, and of these eleven died within the first six months. Therefore, 381 (97.2 per cent) lived more than six months, *etc*. It will be seen that the greater number of deaths occurred in the first, second and third year. The cumulative column demonstrates the number of people alive in the successive years which is objectively shown in Graph S.

*A study has been made of the age distribution and percentage of patients operated upon for carcinoma of the breast who survived ten years or more — (Table XLV). The total number of possible cases was 573, this number including the known dead and all patients living that were operated on prior to 1921 with the exception of those concerning whom there was no knowledge as to the length of life after operation. Of these patients seventy-one (12.2 per cent) lived ten years or more. The percentage of patients living ten years or more for each age group, with the exception of seventy to seventy-*

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nine, is practically the same, varying from 10.4 to 13.2 per cent. The average length of life for these individuals living ten years or more after having been operated on for carcinoma of the breast was calculated (Table XLVI) for the various age decades and it was found to be practically the same, 14.6 to 18.9 years, regardless of the decade. However, when these averages are compared with the normal life expectancy, it is at once apparent that there is a progressive decrease in the latter for each decade from thirty to seventy years of age, whereas the average length of life for the patients living ten years or more for each successive age decade more closely approximates the normal life expectancy for that period up to age sixty, when the average

TABLE XLVI—*A Comparison of the Normal Expectancy of Life with the Average Post-operative Length of Life of Patients (Having Carcinoma of the Breast) Who Lived Ten Years or More*

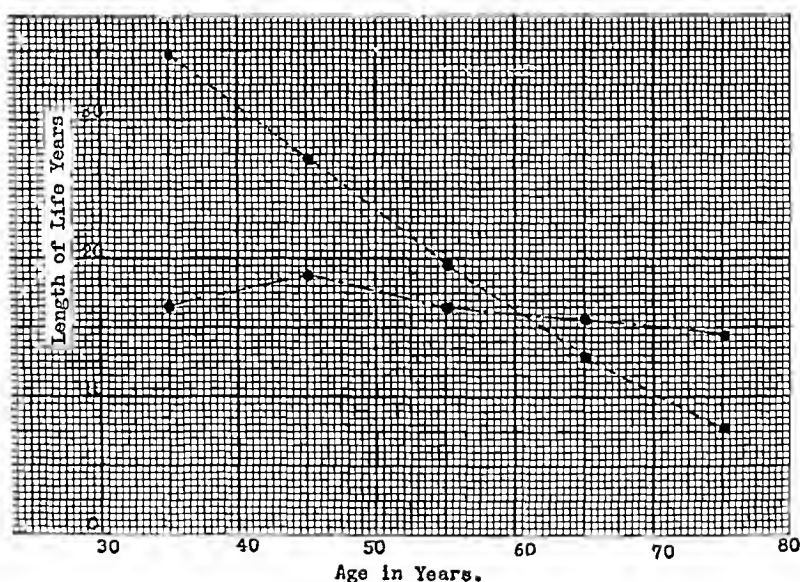
Age in years	Normal expectancy in years	Average post-operative life of pts. who lived more than ten years
30-39 years	34.88	16.6
40-49 years	27.16	18.9
50-59 years	19.63	16.5
60-69 years	12.99	15.5
70-79 years	7.85	14.6

Shows the average length of life for these individuals living ten years or more after operation. Calculated for the various age decades and is practically the same. When these averages are compared with the normal life expectancy it is at once apparent that there is a progressive decrease in the latter for each decade from thirty to seventy years of age. Whereas, the average length of life for the patients living ten years or more for each successive age decade more closely approximates the normal life expectancy for that period up to age sixty when the average length of life for this group was greater than normal. See Graph T. Those operated on after sixty and living more than ten years will have lived out their normal life. The later the age decade when they are operated upon the greater chance they have of completing their normal span of life, providing they live ten years.

length of life for this group was greater than normal (Graph T). All those from sixty on that have lived ten years or more will have lived out their normal life. The later the age decade in which they are operated upon the greater chance they have of living out their normal span of life, providing they live ten years. Of this group of seventy-one patients who lived more than ten years, forty-two (59.2 per cent) were operated upon within one year of the discovery of the tumor. In twenty-seven (38.1 per cent) the duration of the disease prior to operation was longer than one year. In two the duration was unknown. Apparently in this group of patients who lived over ten years, an early diagnosis and operation were beneficial. Although bearing no relation to the above-mentioned forty-two cases there were also forty-two, or 59.2 per cent, of the seventy-one patients living more than ten years who had no regional metastases at the time of operation, although twenty-seven (38.1

per cent ) did have axillary regional metastases These figures go to show that even in the presence of metastases the outlook is not entirely hopeless

In fact, unless remote metastases can be demonstrated in the lungs, liver, bony skeleton or entirely outside the field of operation one is not justified, according to our judgment, in pronouncing a patient inoperable This opinion is based on the review of the hospital histories, which, together with the follow-up study, prove that in many cases there was a large breast tumor which had even ulcerated through the skin, with metastases to the axilla and even to the neck of the same side, and yet the patients were cured of *clinical* cancer by operation We quote one case which illustrates the futility of attempting to give a prognosis from the clinical examination as well as the histological section This patient, Surgical No 18058 was operated upon by Doctor Sowers in 1905 at the age of sixty-six She had a large tumor of long



GRAPH T—Age in years A comparison of the normal life expectancy with the average post operative life of patients having carcinoma of the breast who lived ten years or more Normal life expectancy — — — — — Average post operative life — — — — —

duration of her left breast, which had ulcerated through the overlying skin There were regional metastases to the left axilla and neck A radical Halsted Thiersch graft operation was performed, requiring over four hours for the completion of the operation Not only was a very large area of skin removed but the chest-wall, left axilla and left supraclavicular regions were meticulously denuded of all tissue The patient had an uneventful convalescence and in June 1931 was living and well at the age of ninety-three Examination of the specimen removed showed the tumor to be a large infiltrating scirrhous carcinoma which invaded not only the overlying skin and subcutaneous tissue but also the underlying pectoral fascia and muscle The operator and pathologist considered the prognosis at that time as poor This, we think, is an example of what can be accomplished by allowing a large margin about the tumor and sacrificing a sufficient amount of skin combined with a most careful

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radical procedure associated with patience and enthusiasm. Who can say that the disease has spread beyond *possible* operative limits, and deem it not necessary to make the greatest surgical effort? The only worthwhile modification of the Thiersch graft operation is to make it more, not less radical. It would seem far better to err on the radical side and take as much time at operation as is necessary rather than perform a rapid excision of the breast and not be radical enough. This one case of Sowers', which is almost one in

TABLE XLVII — *Classification of 789 Cases of Carcinoma of the Breast as to Type of Tumor and as to the Presence or Absence of Metastases*  
*Johns Hopkins Hospital (1889-1931)*

Type of tumor	With metastases		Without metastases		No data regarding metastases		Total No of cases
	No of cases	Per cent	No of cases	Per cent	No of cases	Per cent	
Scirrhus	365	79.2	89	19.3	7	1.5	461
Adeno	46	68.7	20	29.9	1	1.5	67
Medullary	155	76.4	47	23.2	1	.5	203
Simple carc	9	100.0	—	—	—	—	9
Sarcoma	1	33.3	2	66.7	—	—	3
Papillary	—	—	1	100.0	—	—	1
Colloid	5	41.6	7	58.3	—	—	12
Paget's	4	66.7	2	33.3	—	—	6
Comedo	1	100.0	—	—	—	—	1
Cancer in cyst	7	77.7	2	22.2	—	—	9
Colloid adeno	1	100.0	—	—	—	—	1
Intracystic papilloma	—	—	1	100.0	—	—	1
Unknown	6	40.0	1	6.7	8	53.2	15
Totals	600		172		17		789

Six hundred patients had metastases while in 172 their presence could not be demonstrated. It will be seen that 454 were affected with scirrhus and that of this number 365 or 79.2 per cent had metastases and 89 or 19.3 per cent were without them. The percentage for the medullary type was practically the same. Out of 202 cases, 155 or 76.4 per cent, had metastases, 47 or 23.2 per cent had none. Of the groups classified microscopically as adenocarcinoma, which contained sixty-six cases, forty-six or 68.7 per cent had metastases, while twenty or 29.9 per cent had none.

a thousand, justifies the most radical surgical treatment in cases of extensive involvement even though the prognosis is apparently hopeless, as long as the disease has remained within possible operative limits.

An analysis was made of 772 cases in regard to the relation of metastases to the type of neoplasm present. Table XLVII reveals that in 600 patients metastases occurred, whereas in 172 cases none were detected. Of the patients suffering from scirrhus carcinoma 79.2 per cent had metastases and also

76.4 per cent of those with medullary cancer. Only 29.9 per cent of those with adeno-carcinoma had metastases.

It has been possible to analyze the cause of death in the 420 cases comprising the known dead group (Table L). It is to be noted that of this group 206 patients (49 per cent) were known to have died of carcinoma. In sixty-one (14.5 per cent) the causes of death were given as due to other conditions, which, when one takes into consideration that many of these follow-up letters were answered not always by general practitioners but also by members of the family, the accuracy of some of the diagnoses is questionable. If only those cases in which it was almost certain the patient died, at least with car-

TABLE XLVIII — *The Growth of the Tumor, According to Age, for 415 Cases of Carcinoma of the Breast. These Patients Are Known to be Dead*

*Johns Hopkins Hospital (1889-1931)*

Years Age	Rate of growth		
	Slow	Rapid	Slow to rapid
	Per cent of cases	Per cent of cases	Per cent of cases
20-29 years	11.1	44.4	—
30-39 years	26.7	16.0	8.0
40-49 years	32.3	13.5	12.0
50-59 years	28.4	14.7	13.8
60-69 years	25.3	10.7	6.7
70-79 years	28.6	7.1	14.3

The percentage of rapid growth was much larger for the twenty to twenty-nine age group than for any of the succeeding ones. In the age decade seventy to seventy-nine, 28.6 per cent of the cases had slow-growing tumors. It would seem that under thirty years of age the larger percentage of patients had rapid-growing tumors and over seventy there is a larger percentage of slow-growing tumors. In the ages thirty to sixty-nine there appeared to be very little difference in the rate of growth.

cinoma if not of it, are removed from this group of sixty-one, there are seventeen cases or 4 per cent in which the cause of death was probably not carcinoma.

The group of patients concerning whom no information could be obtained numbered 153 (36.4 per cent). Thus, of 49 per cent or 206 cases of the 420 known dead group we have unquestionable information that the cause of death was carcinoma. It is highly probable that of the sixty-one cases or 14.5 per cent who were supposed to have died of other causes, at least forty-four or 10.5 per cent died of carcinoma. Therefore, of the 420 cases, in 250 (59.5 per cent) there probably was carcinoma present at death. The total group concerning which we have definite information consists of 206 having died of carcinoma and sixty-one (22.8 per cent) were supposed to have died of other causes, this latter, however, we doubt, as stated above. Thus 206 (77.2 per

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TABLE XLIX—Duration of Tumor before Operation, with Size of Tumor, 414 Cases (Dead) Carcinoma of Breast

Duration of tumor before operation																
Size of tumor	3 mos	6 mos	9 mos	1 yr	2 yrs	3 yrs	4 yrs	5 yrs	6 yrs	7 yrs	8 yrs	9 yrs	10 yrs or more known	Un- known	Per cent	Total
Very small																
Small	1	1		1												
Moderately large	21	13	11	8	18	3	1									
Large	14	13	6	9	13	4	3	3	3	1						
Very large	33	38	31	9	39	16	10	7	2	1						
Unknown	1	3	5	11	8	1	1									
Totals	70	70	53	65	79	24	17	10	2	3	1	16	4	100	0	414

Six cases were omitted because of bilateral involvement at time of admission

The classification as to size was made on the basis of the history, physical examination, operative and postoperative findings. The size of tumor, 414 Cases (Dead) Carcinoma of Breast

Occupation by the tumor of practically the entire breast Very large, not only the entire breast but also the axilla and the skin of the breast. There did not seem to be any relation between size of tumor and duration of tumor before operation. The size of tumor, 414 Cases (Dead) Carcinoma of Breast

The classification as to size was made on the basis of the history, physical examination, operative and pathological note. Large size indicated the occupation by the tumor of practically the entire breast. Very large, not only the entire breast but also invasion of the adjoining skin. Six to ten centimeters in diameter was classified as moderately large, and below six centimeters, small, while pea size to three centimeters, and below, very small. There did not seem to be any relation between the size of the tumor and the duration of the disease. It is evident that 33.8 per cent of the patients came in within six months of discovery of the tumor, 46.6 per cent within nine months, 62.3 per cent in a year, and 81.4 per cent within two years.



TABLE L — *Classification of the Causes of Death of the 420 Patients Who Had Carcinoma of the Breast*

Carcinoma	Metastases	Local and regional recurrences *	Causes other than carcinoma	Cause unknown
Opposite breast	8	13	Pneumonia	10
Stomach	12	31	Pulmonary embolus	7
Uterus	3	17	Paralysis	5
Intestines	2	7	Infection	4
Rectum	1	7	Other causes	3
Lungs	10	1	Senile debility	2
Liver	12	1	Tuberculosis lungs	2
Esophagus	1	4	Bronchopneumonia	2
Location unknown	13		Shock	3
			Heart trouble	2
			Gastritis	1
			Myoma uterus	1
			Diabetes	1
			Pneumonia and infection	1
			Myelitis	1
			Hemiplegia	1
			Congestion lungs	1
			Hæmorrhage from recurrence	1
			Sciatica	1
			Uræmic coma, multiple neuritis and brain trouble	1
			General exhaustion	1
			Cerebral embolus	1
			Tuberculosis, peritonitis	1
			Apoplexy	1
			Menigitis	1
			Flu	1
			Myocarditis	1
			Osteomyelitis of ribs and sternum	1
			Myocardial failure	1
			Septicæmia, bronchopneumonia	1
			Broken leg	1
Total	62 14 8%	81 19 3%	63	61 153

\* R R — Regional Recurrence      L R — Local Recurrence      R — Recurrence

Carcinoma

Metastases

Local and regional recurrences

Causes other than carcinoma

Cause  
unknown

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Stomach	4	General	4	Local and regional	3	Pneumonia	2	14
Opposite breast	1	Internal	5	Breast	2	Myelitis	1	
Uterus	1	Bones	3	Suprascapular glands	1	Hemiplegia	1	
Intestines	1	Spine	3	Whole glandular system	1	Diabetes	1	
Rectum	1	Mediastinum	1			Bronchiopneumonia	1	
Lungs	2					Osteomyelitis of rib and sternum	1	
						Uremic coma, multiple neuritis and brain trouble	1	
Total	10						8	14
	18 2%							
		16						
		29 1%						
				7				

Of the 420 cases of known dead, fifty-five or 13.1 per cent had no metastases at the time of operation. Of the group of eight cases in which the cause of death was given as other than carcinoma it is probable that in seven of the eight cases the patients had metastases. This information is obtained from the history in which the correspondence from the patient's physician and family were filed.

cent ) of the 267 known group undoubtedly died of or with carcinoma. If this percentage may be applied in a speculative manner to the 153 cases about which no information could be obtained, and it is only reasonable to assume that approximately the same percentage of this group of 153 would be affected as the 206 group, the result shows that 118 would have died of carcinoma and thirty-five from other causes. In other words, of the 420 known dead patients all but ninety-six (22.8 per cent ) died of or with carcinoma. This estimate is very conservative because more patients would be included in the "died of carcinoma" group if of the sixty-one cases supposedly succumbing to other causes there was a reduction from sixty-one cases (14.5 per cent ) to seventeen cases or 4 per cent , as suggested previously. If this reduction

TABLE LII—*The Causes of Death of Patients Having Carcinoma of the Breast but Who Lived Ten Years or More after Their Operation*

Carcinoma		Metastases		Local and region- ary recurrences	Causes other than carcinoma	Cause unknown
General	1	Mediastinum	1	0	Other causes	1 8
Rectum	1	Internal	1		Senile debility	1
Lung	1	Pelvic bones	1		Pneumonia	1
Liver	1				Bronchopneumonia	1
Stomach	2				Apoplexy	1
Intestines	1				Heart trouble	1
Opposite breast	2				Paralysis	1
Total	9		3	0		7 8

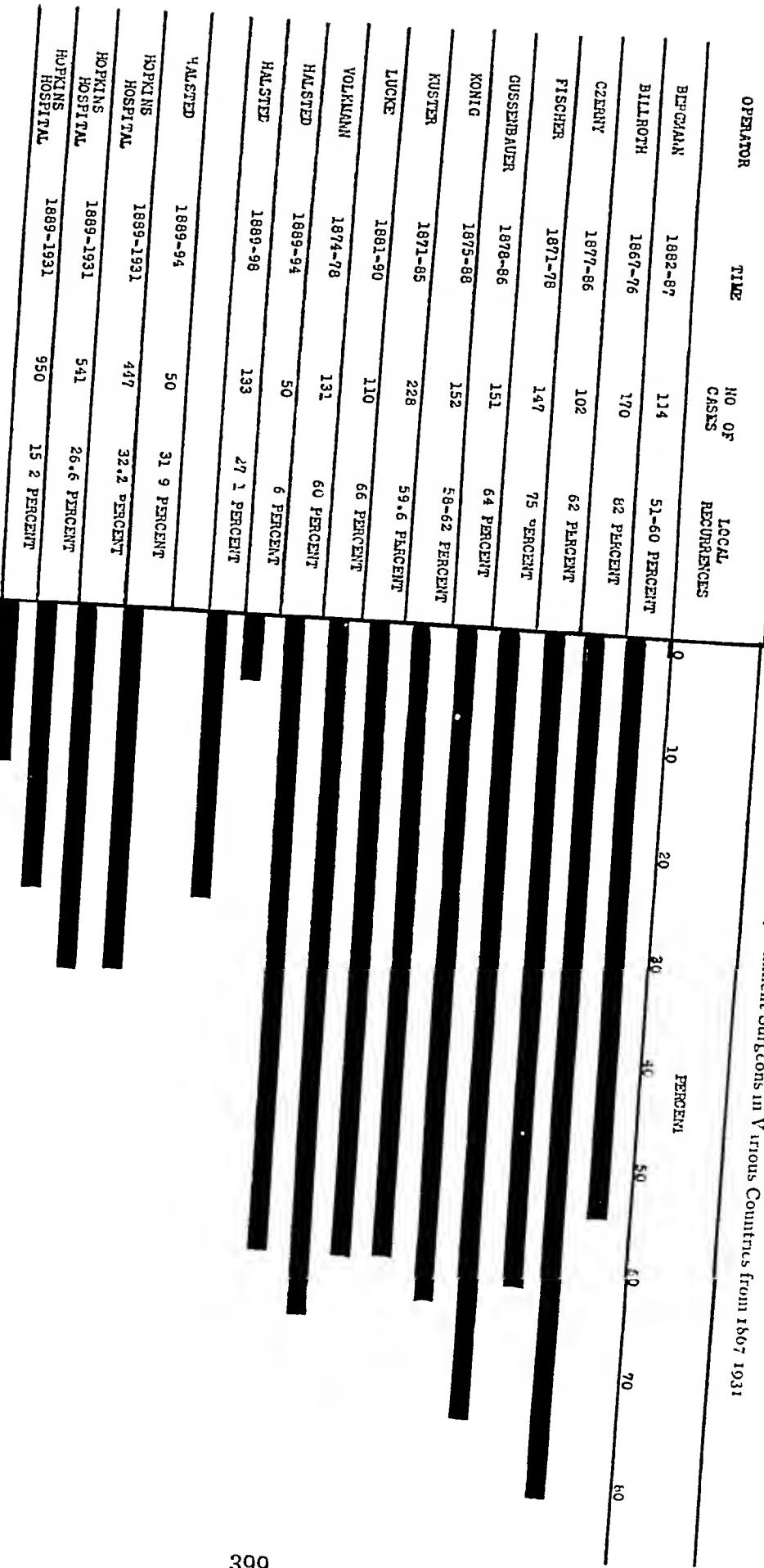
Attention is called to the fact that in this group of twenty-seven patients, or 6.4 per cent of the 420 known dead, which lived ten years or more after operation, there were no local recurrences. Twelve or 44.4 per cent of the 27 died of carcinoma. In eight or 29.5 per cent the cause of death was unknown. Seven or 25.9 per cent died of causes other than carcinoma. A further study of this group revealed that eighteen cases or 16.7 per cent of this group of twenty-seven did not have metastases before operation while nine or 33.3 per cent did have. Fifteen or 55.6 per cent had the Halsted Thiersch graft operation while twelve or 44.4 per cent were operated upon by the closed plastic method.

be permitted, then in 93.2 per cent of the 250 cases the cause of death was probably carcinoma. Providing the unknown group of 153 cases were similarly affected, then 143 patients of this group would have died with carcinoma and only ten without it. Thus of 420 cases all excepting seventy-one patients would have succumbed to or at least with carcinoma present.

As shown in Table LII, in the group of known dead there were twenty-seven patients, or 6.4 per cent, that lived ten years or more. Of this group twelve (44.4 per cent ) died of carcinoma. Seven or 25.9 per cent succumbed to other causes, while in eight or 29.5 per cent there were insufficient data. In all probability in some individuals in these two latter groups carcinoma was present at the time of death. It is to be recalled that in one of Doctor Halsted's cases there was at the time of death a carcinoma of the liver thirty-two

Bar Diagram U

The Percent of Local Recurrences After Operations for Carcinoma of the Breast by Linnient Surgeons in Various Countries from 1867-1931



The percentage of local recurrence reported by Halsted by 1898 was as shown, 27.1 percent. Of these original 50 cases in which were reported 6 percent local recurrence in 1894 have now been found in 1931 to be really 31.9 percent. The percentage of local recurrence at present in the Johns Hopkins Hospital is dependent on the way in which they are calculated. If the entire series of 950 cases is taken into consideration, which includes those cases lost track of, then the percentage of local recurrence is 15.2 percent. If, on the other hand, the known dead group of 419 cases, eliminating one case in which there was insufficient data, is taken into consideration with 94 patients living and well, the total number comes to 541, of which 144 had a local recurrence, making a percentage of 26.6 percent for the local recurrence in addition to all the patients of the Johns Hopkins Hospital that were operated upon are included excepting 209 cases of those which have been lost track of. This it seems to us is a more true representation of the incidence of local recurrence.

years after operation, during which time the patient had enjoyed good health

The conclusion that the large majority of patients affected with carcinoma of the breast will succumb to this disease is therefore unquestionably warranted. We also feel that this study establishes the fact that a large number of patients are free from *clinical cancer* for a varying number of years following operation, but whether or not a patient is ever completely cured (*in the pathologic sense*) of carcinoma is open to question. Undoubtedly, if operated upon properly the condition may be cured locally, and that is the only point for which the surgeon must hold himself responsible.

It is, of course, always possible that the disease may still remain a localized process which has not spread beyond the limits of operability, and especially is this so in the very early cases that come under observation today. In view, therefore, of our inability to foretell the exact limits to which the disease has spread, a thoroughly radical removal should be done in all cases whether early or late. It is a well-known and proved fact that patients from whom the primary growth has been removed and who have lived without symptoms of *clinical cancer* for many years afterward, finally succumbing to some other malady, were found to have regional metastases in which microscopical carcinoma could readily be demonstrated (Peugniez' case\*). It would also seem that carcinoma may vary not only in its rate of growth but as well in its damaging clinical effects when the cells are removed from their primary site to a different type of tissue, such as a lymph-gland or another organ. This idea receives additional support from the observation that the post-operative longevity of patients without local recurrence is greater than of those with a reappearance of the growth in the operative field. This is true despite the fact that in both there may be remote metastases.

Hence it follows that, *regardless of the extensiveness of the disease, so long as it remains confined within possible operative limits, it is incumbent on the surgeon to perform the most radical and meticulous operative procedure, including a far wider excision of skin than has been customary, in even the Halsted Thiersch graft procedure as performed in the majority of instances in the past, for it is only by this method that the proper amount of skin and subcutaneous tissue will be sacrificed. There alone exists the possibility of reducing local recurrence to a minimum.*

Peugniez, in 1899, operated upon a patient, removing practically all of the stomach, thus performing a very radical subtotal gastrectomy. The patient died in 1925 of lobar pneumonia at the age of seventy-seven. The post-operative life was thus a period of twenty-five years. Examination of the stomach which was removed at the time of operation proved the condition to be carcinoma and autopsy twenty-five years later revealed the retro-peritoneal lymph-glands and the liver both involved in carcinoma whereas the remaining portion of stomach was normal. This patient, however, was cured of clinical cancer, although still infected with microscopical cancer.

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\* Peugniez, P. Une gastrectomie pour cancer remontant a vingtequatre ans. Bull Acad de Med, vol. xcii, p. 831, Paris, 1924.

# CANCER OF THE BREAST\*

THIRTY-TWO YEARS' EXPERIENCE

BY EDWARD J. ILL, M.D.

OF NEWARK, N. J.

THE importance of the subject to be considered is shown by the fact that 39.3 per cent of the total mortality from cancer in the female is due to cancer of the breast. This mortality is taken from an analysis of thirty-one thousand deaths.

In 1924, I was discussing the end-results of cancer of the breast with a very good surgeon. He remarked sarcastically that he had had eighty-eight cases and eighty-eight deaths in less than the five-year period. This study was prompted by the query, Have you ever seen cases remain well after the operation? Since this date (1924) I have been constantly looking out for the end-result, as old patients presented themselves or as correspondence gave some information. At that time I have been told that reliable statistics of the operation in regard to the ultimate operation outcome of cancer of the breast are rare. I noticed that some one said, "All die in the 5-year period." It seems to me that the outlook should be getting better in the hands of the conscientious surgeon. Thanks to the efforts of the American Society for the Control of Cancer, cases are coming earlier to us. I can now present the study of thirty-three years of surgery for cancer of the breast. It has taken me seven years to compile these records and thus to be in a presentable condition for study and report.

When Halsted reported his first operation for cancer of the breast in the *ANNALS OF SURGERY* in 1898 I was much impressed with his work.

An immediate study of the anatomy of the breast in its relation to the pectoral muscles, the subclavian vessels, the lymphatics and nerves and axillary tissue, was made. It all looked so scientifically correct as dissection after dissection on the cadaver was made. All the cases operated on and reported in this paper followed exactly the description given by Doctor Halsted, except in two where Jackson's incision was made, hoping to leave a less tender scar. In this I failed and promptly returned to the original operation of Halsted. I have never changed from this operation. I have not made my patients experimental guinea-pigs, for I well knew that years must elapse before one can come to a decided conclusion.

The operation of starting the dissection in the axilla never appealed to me for reasons that would take too long to discuss. There are some fundamental principles involved in the operation, as I look at it now after many years of study and observation. They seem to me of the utmost importance.

Fixed involvement of the axillary glands, and, when it can be made out,

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\* Read before the Practitioners' Club of Newark, November 2, 1931.

of the subclavicular glands, are no longer cases for operation with the view of cure. I have had many cases, however, go on over the five-year period with movable glands.

Dr James Ewing agrees with this view and once said "Surgeons will have to change their indication on these cases or they will dishonor their calling." His prognosis was a shortened life and in this Doctor Ewing is surely correct. I had long ago come to the same conclusion.

We may be called upon to operate as a palliative measure but the result will surely shorten the patient's life. Supraclavicular involvements are an absolute contra-indication for any operation because secondary involvements may with confidence be looked for. X-rays of the chest and the bones of the arms will usually satisfy our curiosity and prevent a useless and harmful

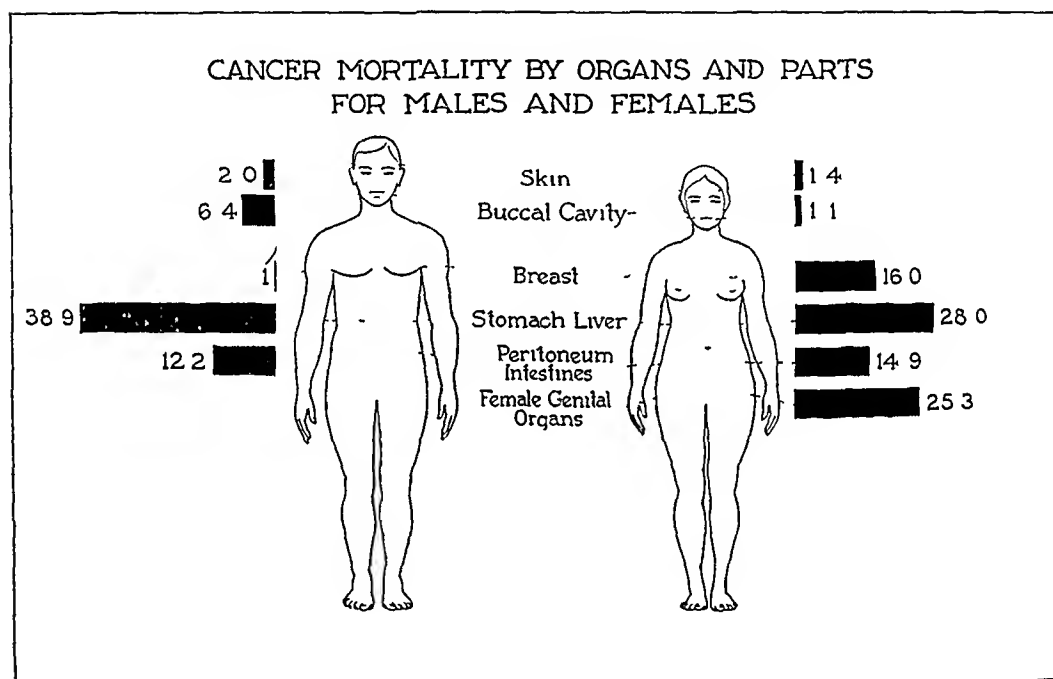


FIG. 1

operation. In the pre-Halsted days I often resected parts of the clavicle, which was invariably followed by an early local and general recurrence.

Edema of the skin, if it is not due to an abscess, shows an extensive involvement beyond the local area and seems to me to be a contra-indication for any operation. Fischer calls this subepidermoidal carcinoma.

The incision should be wide from the tumor area, giving a large space to work in and at the same time keeping wide away from the tumor. It should begin at the bicapital ridge of the humerus. Early in my work I did much transplantation of skin but of late hardly any, and then only in very thin women. It is rather important to make an incision through the skin and fat from the insertion of the scalenus muscle into the clavicle to the upper part of the circular incision around the breast. This allows a very great abundance of working space under the clavicle. The skin

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incision far from the cancerous nodule probably accounts for the very few local recurrences noticed in this study

The skin should be dissected from its underlying tissue away from the tumor far in every direction, leaving a good portion of fat with the skin, otherwise, sloughing will result. The incision should be carried down to the chest wall and pectoralis major muscle everywhere, except in the axillary and lateral chest wall, where the dissection is made from within out, severing the whole mass after all the subclavian and axillary glands, still attached to the breast, are removed, and *removed in one piece*.

It is of the utmost importance that we now cut the pectoralis major from the bicipital ridge and carry the dissection to the chest wall. The muscle is cut away from the chest wall and thus is exposed the pectoralis minor muscle. Any areolar or fascial tissue on the minor muscle is dissected upward and the muscle is then cut across. All the subpectoral vessels are ligated and we now have the whole subclavicular and axillary space before us. It is also important that any fat or glands should not be separated from the vessels except as part of the original tumor. A gland left in and dug out separately spells early death to the patient, always provided that such a gland is cancerous. I shall come to this again later on.

Ligation of all the vessels should be made with very fine catgut—No. 00—at the end of every step, excepting the large subpectoral vessels. Double ligation of all the veins and arteries coming from the subclavian and axillary vessels should be made, severing them between the two. This is strongly urged because any bloody infiltration of subclavicular and axillary cellular tissue makes a fine dissection impossible.

The dissections in the axilla should be carried on backwards and outwards until the teres major, the subscapularis, and the edge of the latissimus dorsi are in sight. The external thoracic nerve need not be sacrificed. I notice that the axillary fascia is often lost sight of. If we remember that it begins at the outer edge of the pectoralis major and corococlavicular fascia in front and extends to the lower border of the latissimus dorsi behind, we shall not go wrong. Both structures must be cut and *removed in one piece with the original mass*. The loose areolar tissue makes blunt dissection easy, always pushing the vessels from the surrounding tissue, and not the reverse. The serratus magnus is always plainly in sight at this time. The thoroco-acromial artery and the lateral thoracic artery and veins should be ligated doubly so as to stop any return flow of blood. Often enough the subscapular artery and vein arise high up on the axilla and need a double ligature.

After removal of the tumor mass, careful treatment of even the smallest bleeding point is indicated. Closure of the wound with interrupted or continuous suture of No. 1 catgut is made. Where there is any tension a figure-of-eight suture of silkworm is done. If it is found that these sutures are inefficient bone plates or metal plates can be used. Stab-wound drainage has been my choice. If radium is to be applied large tubes of rubber are advisable all to be removed in twenty-four or thirty-six hours.



It is most important to remove all the lymphatic and areolar tissue in the subscapular subclavicular and axillary space in one piece connected with the original tumor. Any incision between cancerous glands and original tumor makes for a gloomy prognosis and death at an early date. It is remarkable, however, how often one finds glands that are not malignant.

I am under the impression that post-operative radiation of X-ray and radium, when cancer glands were found and not expected, has given the patient longer life. I have in mind a lady operated on ten years ago with a large bunch of subclavicular infiltration, who is today entirely well, and another who with supraclavicular recurrence is well now after four years. This subject, however, will have to be the object for further studies.

Doctor Pfaler says that "radium is a most useful agent in the treatment of palpable recurrent or metastatic nodules from carcinoma of the breast." It will be right to talk of biopsies here. I am often glad to have the opinion of the pathologist at this time, well recognizing the fact that in the hurry with which a frozen section is made serious errors are likely, and do occur. If the error occurs, and it is often unavoidable, an early death is likely. I have in mind the case of a woman, who died in eight months, when the report came ten days later that she had a cancer. On the other hand, I have removed a carcinoma under misapprehensions, followed the primary operation in ten days by a radical one and the patient is living, fifteen years later, and still well.

When a biopsy shows a cancer, the wound should be swabbed with pure carbolic acid and tincture of iodine, equal parts, and sewed up—*absolutely tight*. The area of operation should then again be disinfected, all instruments, towels, gloves and gowns changed, and the radical operation proceeded with.

The cause of cancer of the breast has been the study of many. A blow is usually given as an inciting cause and I think it may be so, as my histories often enough say. On the other hand, the breasts are prominent organs and subject to external insult. For years I have been questioning my patients on the subject of chronic mastitis preceeding cancer, and have thus far seen but one definite case. Chronic mastitis is exceedingly common. Papillary duct cyst adenoma shows to be cancerous in about one out of fourteen or fifteen cases in my experience, and this should be borne in mind.

Cancer of the puerperal breast is rapidly fatal and has been so in my hands.

Those who have made a study of records extending over many years know of the very great difficulty encountered. It is now seven years since a follow-up system has been pursued. It surely was exceedingly difficult. Facts had to take the place of impressions. Many a surgeon operates when in his heart he does not know if he is doing harm or good. Some of my cases had poor addresses or had moved away, many letters being returned unopened. Some have come at my invitation, as many as twenty in one morning. Many have answered letters. In some cases I learned through

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relatives of deaths and this was corroborated by a study of the records of Vital Statistics in Trenton. Some have turned up for other troubles and being well did not understand why they should answer my letter. I have searched the statistics of the Vital Department at Trenton for those whom I could not trace otherwise. This gave me some interesting and surprising information. Of this, more later. In this report I find that I did the Halsted operation 266 times in thirty-two years, *i e*, up to January 1, 1930. Those operated on since were too recent to draw any deduction from, there being seven such cases, all well at present.

Among these, 175 were married, 48 single, and the rest were not noted. This means that the records show 36 as many married women have cancer of the breast as single ones. It looks like a preponderance of the disease in the married. When we remember, however, that 20 per cent of all women after thirty-five years are single it immediately becomes apparent that cancer of the breast is more frequent in the unmarried woman.

Doctor Summers, of Omaha, says that the relative proportion in the death rate is 44 per 100,000 population for the married as compared to 109 per 100,000 in the single. (In the October, 1931 number of *Surgery, Gynecology and Obstetrics*.)

There were twenty-three cases where the address was so bad that no search was made. 135 letters were returned and the cases could not be traced. Often enough the attending physician would not remember the case. Forty-seven cases lived over five years. Among these there were five who lived six years, two who lived seven years, three who lived eight years, two who lived eleven years, one case each who lived twelve, twenty-one and twenty-four years respectively, and, seven who died from causes in no way of a cancerous nature in from three to sixteen years.

This makes altogether fifty-four cases that had no recurrence or about 20 per cent of what I call five-year cures.

If I add to the above forty-four cases recorded in the Department of Vital Statistics at Trenton as living and seven as having died from other causes I find that the ultimate recoveries are over 30 per cent.

Among my personally kept records there were five cases well at the end of four years and three years respectively and two were well at the end of two years. Forty-four cases died of cancer in less than two years. I have had a recurrence in the scar five times.

Because of the large number whom I could not trace I searched the records of the Vital Statistics in Trenton with the following interesting result. I searched for the names of 102 patients. Of these there was no record of death in forty-four cases. Now they either left the state or else are living and well at the present time. The search extended from 1899 to 1929, inclusive. I find that twenty-six are reported as having died from cancer of the breast in anywhere from four months to nine years after the operation. Many (11) died in the first year.

I found three as having died from tumor of the brain, likely cancerous in seven one and two years from the time of operation

Cancer of the lung is reported in six cases, four in one year and one in five and two years respectively Two cases died of cancer of the liver within one year One case died of cancer of the uterus in three years One is said to have died of cancer of the sacrum in two years and one each of cancer of the pancreas and stomach

The foregoing forty-one cases, or 40 per cent, surely died from cancer in one form or another There were some doubtful reports, thus One is said to have died of anæmia in one year, which was likely cancer One died of myelitis in four years, which was surely cancer of the spine Acute bronchitis in a woman of forty-six years, two years after the operation, is doubtful, as is also a tuberculosis of the lung in the same length of time There was one death from cardiac disease in five years, three due to chronic Bright's in six, five, one and three years respectively One each died from lobar pneumonia and suicide in six years One had apoplexy in four years at the age of seventy-seven years, and another in five years There was also one reported as having died from senility at seventy-seven years, thirteen years after operation

To sum up, I find that forty-one had cancer, four were doubtful but likely cancer, and eleven that could not be called cancer by any stretch of the imagination Forty-six cases, then, lived without a recurrence of cancer

It is right that I should say that three cases were done which showed no cancer I am, however, not discussing the diagnosis of cancer of the breast except to say that the best of us have gone astray Our diagnostic shortcomings must, however, not make us sacrifice a whole breast for an innocent tumor I also wish to say that secondary operations are worse than useless

A few cases of excision of the subclavian or axillary veins were done All patients died within the year Wound of the subclavian has occurred once and was relieved by fine silk sutures

Two patients died, one from hæmorrhage into the cellular tissue and the other one from acute dilatation of the stomach, making 0.8 of 1 per cent

I have been struck during my searches of the many cases where other cancers have occurred in the same family—once four cases in the same house and family within twenty years

A removal of the second breast occurred in five cases, after an interval of six, one, one one and three years, respectively We note recurrences in the lung fifteen times, extending from one to twenty-one years, in one case after six years, there having been an axillary infection

We had cancer of the spine in four cases and of other bones three times One case of cancer of the spine who was bedridden is again up and about after six months' treatment with selenium She is among the above four cases and the original operation was fourteen years ago There was cancer of the long bones and of the lung twice We record cancer *en cuniasse* but once Three times we heard of spontaneous fracture of the long bones and once fracture

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of both radii and femur after three years We saw a carcinoma of the vagina after eight years We judge that this was a new infection since this was of the squamous variety Once I attempted to remove the glands of the supra-clavicular space with the result of a wound of the thoracic duct, which, however, closed up in a few days She died shortly of the disease In one case we got a severe infection but the patient got well and remained so for over eight years, and is still well In one case we had a recurrence in the axilla in fifteen years We note five cases where glands were infected and life was prolonged for twelve, eight, three, eight and seven years respectively and all are still living

I did extensive skin grafts three times in my early work I have learned to avoid this

Hopeless cases to start out with I have not operated on, except in rare instances, where ulcerations produced great pain or foul discharge and then it was a simple amputation

In all, I noted sixty-one recurrences in from eight months to twenty-one years, in my personal experience, there being two in eight months, one in nine months, eighteen in one year, fifteen in two years, six in three years, two in four years, three in five years, four in six years, and one each in eight, nine, ten, eleven, twelve, thirteen, fifteen, nineteen and twenty-one years

In ages they range from twenty-seven to seventy-seven years I have seen many cases of atrophic cancer in women older than eighty but thought they would live longer if let alone In this opinion I was borne out by a few cases and an early bad recurrence when operated on by others

As to their ages, there were three in the twenties, twenty-three in the thirties, ninety-four in the forties, seventy-seven in the fifties, forty-nine in the sixties, and twelve in the seventies, making a total of 256

In three cases no age was given and seven occurred since January 1, 1930 I was wondering if the forties showed an increase of cancer over the fifties, and looking up the statistics of the census bureau of 1920 of the United States Government, I find that the number of women in the forties is 6,403,093 and in the fifties is 4,413,610 In other words, there are 2,000,000 more women living in the forties than in the fifties, which would indicate that there are relatively 33 per cent more cases of cancer of the breast in the fifties than in the forties This is borne out by the number of deaths from cancer of the breast in the registration area of this country for 1928 Percy, in a report of 203 cases, reports the average age to be fifty-three years in the registration area There are 1,770 deaths in the forties as compared to 2,603 in the fifties—again practically 30 per cent more

Now that we are having so large a colored population in the North it is of interest to know how many colored women die of cancer Again the census of 1928 speaks of 9,208 white women dying of cancer of the breast, but only 624 colored In my own experience I have not operated on a colored woman, but I have seen one in the practice of a colleague It is to be remembered that about only 10 per cent of our population is colored In other

words, there are two-thirds as many colored who have cancer of the breast as white, considering the relative number of both. In a paper written by Doctor Matas in 1896, he definitely says that "the Negro does not enjoy the immunity to malignant disease which has been heretofore supposed." Doctor Hoffman, in his book on "Mortality of Cancer Throughout the World," speaks in a like strain. That there is less among the Negro we all agree upon. In the male Negro, however, cancer of the breast is twice as frequent as in the male white.

Through Doctor Hoffman's reports valuable statistics are available in regard to the increase of cancer during the past few decades among various peoples and races.

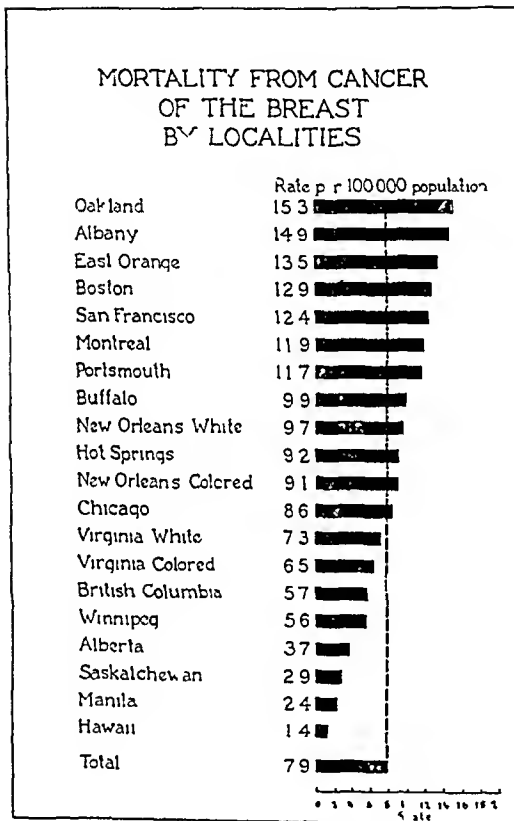


FIG 2

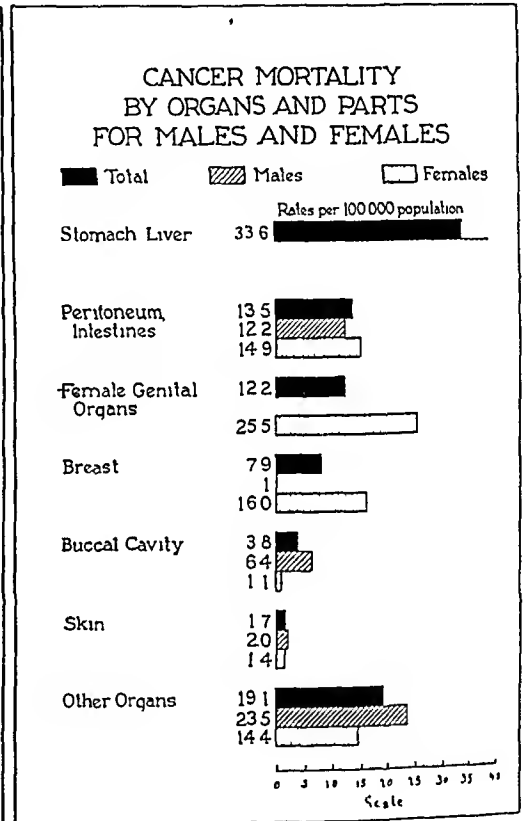


FIG 3

The mortality of cancer of the breast in the registration area of the United States in 1927 was 9,580 and in 1928 was 10,056, or an increase of 470. It is of interest to know that the "proportion of deaths from cancer of the breast in the mortality from cancer in all forms has changed only from 9.1 per cent in 1920 to 9.2 per cent in 1928. It has remained practically the same. We also learn that the death rate per 1,000,000 population in England was 158.4 in 1901 as compared to 1,957 in 1929. There is a very considerable increase in Australia. It has increased by 211 in ten years per 1,000,000, but then the female population has increased in that time by 600,000. There has also been a marked increase in San Francisco of twenty-two cases.

Patients with cancer of the breast live longer, being an average of thirty

## CANCER OF THE BREAST

months as compared with all other forms where it was only twenty months. This fact must be considered in our aspect as to whether we really prolong the average life by operation. It is interesting to know that cancer of the breast is 8.8 per 100,000 for the country at large while for the state of Maine it is 12.8. No explanation is forthcoming for this remarkable discrepancy. Of course, some single sections have a less mortality, like Florida, where it is only 3.8 per 100,000. Statistics also show that cancer of the breast in the male is less than 1 per cent of that in the female and that the average age of the male is twenty years more than the female. The exact figure is seventy-five years in the male to 55.8 in the female. These figures repeat themselves again and again. Even in such widely separate locations as San Francisco and New Orleans, where the population is so different, do we find this dissimilarity. The only exception I find was in Chicago, where the average age was fifty-nine years. I know of only one male, a physician, who had cancer of the breast at seventy-five years.

It is well known that certain less civilized people are less subject to cancer than those of a higher type. There is comparatively little cancer of the breast in the Japanese, the Hawaiian Islanders and the American Indians. Doctor Hoffman has never been able to trace a case of cancer of the breast in an American Indian, though they do die from cancer of other organs. What the explanation may be I am unable to say. The increase in cancer of the breast has been remarkable in Canada, being 4.5 per 100,000 in 1914 to 9.2 in 1923, an increase of nearly 5 per 100,000 in nine years. There can be no question about the increase of cancer of the breast at least. In Hamburg, Russia, and Sweden it rose from 39 in 1917 to 53 in 1921 per 100,000. In Holland it rose from 30 cases per 100,000 in 1905 to 40 in 1920. Why Hawaii should have so low a rate of cancer of the breast as 3.3 per 100,000 is a question of great interest.

In closing I want to say that there is a great move to give up the surgical removal of the diseased breast for the treatment with radium or X-ray. While I have seen some good results I have not yet been able to assure myself that I want to give up the early cases for the newer method of treatment. It has taken three decades of surgical experience in my hands to come to some conclusion. The advocates of the newer treatment will have to show many years of experience before definite conclusions can be reached.

# THE RESULTS OF TREATMENT OF MAMMARY CARCINOMA

By SURGICAL AND IRRADIATION METHODS AT THE MEMORIAL HOSPITAL,  
NEW YORK CITY, DURING THE DECADE 1916 TO 1926\*

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ATTENDING SURGEON TO THE MEMORIAL HOSPITAL

THE medical profession has been and still is attempting to evaluate irradiation therapy in cases of mammary carcinoma. Surgeons in particular have urgently asked for an answer to the query, "To what extent may irradiation be relied on, in the cure of mammary cancer?" The study herein reported is made in an attempt to answer this question. Many inquirers have become discouraged waiting for the satisfactory answer to arrive. However, it will eventually come. The dissatisfaction is due to the following reasons:

*First*, the over-enthusiastic reports of certain observers have definitely closed the mind of some to a belief in ANY report on the value of irradiation, no matter from what source.

*Second*, the constantly changing irradiation technic, with its resultant changes in statistical results, has led to great confusion as to what are the exact end-results.

Irradiation is the youngest of the medical sciences. It must therefore follow that there will be innumerable and constant changes taking place until it is finally decided which of the many technics, methods of applications, types of filters, voltage, etc., are best suited for a particular case. This takes *experiment, experience* and *years* to work out. The information seems long in coming—AND CORRECTLY SO, but it is impossible to incubate facts and bring out correct conclusions. Irradiation methods have changed so rapidly during the short career of this science that by the time one method has been thoroughly tested over a period sufficiently long to report five-year results, a new technic has been developed which completely replaces the former. This is obviously highly unsatisfactory to the physician who seeks exact information on the reliability of irradiation treatment, but also equally unsatisfactory to the physician who is working in the field where irradiation is employed either as a complete method of therapy or as an adjunct to surgery. Moreover, the shifting status of end-results of the irradiated cases unfortunately opens wide the door for over-statement by the unscientific or the unscrupulous enthusiast. The final word on irradiation results cannot be voiced today. There is every probability that years will pass before the ideal technic and the ultimate method shall have been settled. As a corollary, many of the methods of treatment herein employed will be subject to change with the passage of time.

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\* Read before the New York Surgical Society, March 25, 1931

## RESULTS OF TREATMENT OF MAMMARY CARCINOMA

In the meantime, the fact is being commonly accepted and rather widely adopted that irradiation has an important position in the armamentarium of attack against mammary carcinoma

It should be stated in the beginning, however, that as a general rule mammary cancer is not so radiosensitive<sup>1</sup> nor so efficiently treated by any of the irradiation methods as cancer in certain OTHER organs such as carcinoma of the cervix, basal-cell epithelioma of the skin, transitional epidermoid carcinoma of the nasopharynx, *etc*. There are exceptions, however, to this general rule, as evidenced in the occasional case of mammary cancer, which, under a few treatments by irradiation, *completely disappears*

To cure mammary cancer as a rule it becomes necessary to employ interstitial doses of radium as well as external irradiation by the radium packs, or the high-voltage X-rays. In general, we have given up our attempts to treat this disease by external irradiation alone, we usually fail with this, although there is an occasional exception (see Fig 2 and Case III, following). It requires heavy and prolonged irradiation by both interstitial and external methods to hold mammary cancer in abeyance to the point of "five-year cures"

*The Surgical Treatment*—The end-results of surgical treatment have been especially studied during the past forty years since the introduction of the radical amputation by the methods of Halsted and Willy Meyer in 1894. This new procedure increased the "five-year cures" far above the older and commonly used method of the simple mastectomy. The "five-year cures" by the radical mastectomy of *operable* mammary cancer in the well-known clinics of the world are familiar to all. In general, they vary between 32 per cent and 39 per cent. My belief is that those reports giving much higher cure percentages are to be looked on with suspicion. The following table is sufficient to show a few of the five-year results in some of the American clinics

TABLE I

	<i>Per cent</i>
Greenough and Simmons (Huntington Hospital)	32
Moschcowitz (Mt Sinai Hospital)	34
White (Roosevelt Hospital)	36
Sistrunk and McCarty (Mayo Clinic)	36
Lee (including pre-operative and post-operative irradiation) (Memorial Hospital)	39

It is our impression that there has been but little actual improvement during the past forty years in the surgical technic of the radical amputation. No important procedure has been developed or added, since the fundamental principles were originally laid down by Halsted and Willy Meyer, and no better radical amputation is performed today than that careful and exact operation done by these men years ago. We can, therefore, today take the results of radical mastectomy done by good surgeons as largely a settled surgical problem. Thirty-five per cent, however, as average "five-year cures," is FAR from satisfactory. It seems that out of every three radical



amputations performed on the *operable* cases but one patient survives the five-year period, while two patients do not. It is this cruel fact which impels the surgeon to hunt *elsewhere* than surgery for assistance. The radical amputation is developed up to the point where no further step can be taken in the way of a MORE radical amputation unless the interscapulo-thoracic amputation is performed, sweeping off all the axillary, supraclavicular and post-clavicular tissues with the arm, scapula and clavicle. I am convinced that this procedure would further improve our operative cures, but it is mutilating and would add greatly to the operative mortality. Is this a justifiable operation? At present our operative mortality from the radical mastectomy is practically nil.

The results of surgical treatment are a matter dependent upon dissemination and metastasis. In an analysis made by White<sup>2</sup> in 195 operable cases, he found seventy-seven cases (38 per cent) had clinical axillary disease present, but when a careful microscopical examination was made of the axillary contents, 109 cases (51 per cent) proved to have axillary metastasis. As long as the disease is confined to the breast I think there is at present no more effective method of cure than that of the radical mastectomy, which yields approximately 70 to 80 per cent. But when the disease has left the breast and gone into the axillary nodes or into the loose areolar tissues of the axilla, then the percentage of cures is strikingly reduced, and varies between 15 and 25 per cent. This depends on whether the axillary nodes involved lie in the outer and lower portion of the axilla or at the axillary apex. These figures represent a great failure on the part of surgery to cope with the cancer problem after the disease is present in the axilla. As the disease is present in the axilla in slightly over half of the cases (51 per cent) we must seek for some method which will compensate for the fiasco of our surgical results in cases where the axilla is involved. The only agent on the horizon that seems to offer encouragement is irradiation.

*Criteria of Operability*—It is necessary in order to understand statistical studies to know the exact factors that the author applies to the cases. The definition of operability varies with the individual surgeon. If the patient has an *operable* mammary carcinoma we mean that clinical cancer is limited to the breast or the breast and the axilla. Any extension of disease beyond the axilla into the supraclavicular fossa or into the liver or chest or to distant parts is considered to be *inoperable*. An X-ray plate of the chest is taken in every instance and evidence of extension into the hylum lymph-nodes or along the bronchi will immediately classify it as an inoperable case. The liver is carefully examined routinely and if there is enlargement, nodulation, or jaundice, the case is likewise considered inoperable. The patient is always asked if any pains in distant portions of the body are present. If the patient complains of pain in one or both knees, down one or both thighs, or in the back films of the pelvis and spine are taken for evidence of bone metastasis. Examination is made for nodules which may be scattered in the skin about the affected breast. The opposite breast, axilla and supraclavicular region

are examined. If the diseased breast is red, having an elevated temperature with a sharp line of demarcation rather suggesting erysipelas, careful consideration of "inflammatory carcinoma" is made. This clinical type of carcinoma was described by Lee and Tannenbaum<sup>3</sup> "Inflammatory carcinoma" is a totally inoperable type because the dermal lymphatic spaces are plugged with clumps of rapidly growing cancer cells and it is practically impossible to circumvent the disease by operation.

If the axillary mass be very bulky or fixed, the case is considered inoperable even though no supraclavicular nodes are yet palpable. Even in the absence of supraclavicular disease, if the patient complains of pain radiating down the arm of the involved side the probability is in favor of a beginning carcinomatous invasion of one of the chords of the brachial plexus and the case should be classified as inoperable.

Carcinomatous skin nodules surrounding the breast and extending to the sternum make it improbable that there will be a reasonable likelihood of operative cure. In such a case the skin is so widely invaded that the intercostal lymphatics have usually carried the disease through the pleura into the mediastinum and chest even though the X-ray may fail to demonstrate it. *Fixity* of the tumor to the chest wall as a rule signifies inoperability, but not always, much depends on the *degree* of fixity.

It appears almost superfluous to state the criteria of operability. One, however, is not infrequently shocked to see a patient who has a recent operative scar present supraclavicular disease, or complain of pains in the spine or pelvis, or whose X-ray of the chest reveals a definite evidence of intrapulmonary disease. Any one of these conditions demonstrates that a judicious pre-operative estimate of the operability of the case was not made.

It often happens that an operable mammary cancer is present in a patient who has a co-existing disease of such significance or severity that an operation is definitely contraindicated. Some such conditions are diabetes, nephritis with high blood-pressure, tuberculosis, cardiac diseases, old age, *etc.* In the management of such cases it is imperative that we have exact information on the degree of reliance to be placed on methods of therapy *other* than surgical.

Like other hospitals possessing large equipment of radium and X-rays, Memorial Hospital has been making a sincere attempt to evaluate irradiation therapy. The hospital staff is in a position to observe great numbers of cancer patients. In recent years there are annually admitted to the Breast Clinic about 550 cases. This affords opportunity of treating breast cancer by irradiation, by surgery and by the combination of surgery with irradiation.

*Surgical Methods Versus Irradiation Methods*—If one is to completely comprehend the problem, one must keep in mind that although the *end-results* to be accomplished by surgery and irradiation are identical, namely, to *cure* the patient of a cancerous disease still, *the methods of accomplishment have not one thing in common*.

The *surgical* method of treating mammary cancer aims at the absolute eradication of the entire disease process by a wide, careful radical extirpa-

tion of the breast, its contiguous tissues and its drainage basins. As a rule, the surgeon has but one opportunity to ever cure the patient. If recurrence follows the operation, which it does in approximately 65 per cent of the operable cases, surgery is relegated to the realm of an improbable cure.

The *irradiation* method aims at (a) devitalizing the cancer tissue and (b) at the same time changing the character of the surrounding tissues or the "cancer bed" into a firm, fibrotic and occasionally even a calcific mass, thereby gradually strangling, starving and rendering the cancer cells impotent of cell division and metastasis. In a general way this process is comparable to the ideal result of a properly treated tubercular lesion. In tuberculosis, the bacilli are enmeshed within the tubercle, and surrounded by dense, fibrous and at times calcified tissue. The tubercle bacilli are locked up within a fibrotic and stony prison. The aim in irradiation is really identical—to lock up the disease. It takes patience and time to achieve this aim as it likewise does in tuberculosis. Certain cell changes take place in the cancer tissue, such as hydropic degeneration,<sup>4</sup> nuclear fragmentation, cellular disintegration, *etc*. Simultaneously, the "cancer bed," or normal surrounding tissue, under the influence of irradiation, is going through the slow changes of hyalinization, obliterative endarteritis, fibrosis, mononuclear infiltration, calcification, *etc*. The result is a direct killing effect on a proportion of the cancer cells and a locking-up of the cancer in a fibrotic mass. Some of the disease is virtually still present for years, and, under proper circumstances, can be relighted, just as is true of healed tuberculosis. To accomplish this ideal of permanent cure in the treatment of cancer by irradiation, an *exact* technic must be worked out. This can be attained only by allowing a generous period of time for the mutation of tissues. Great patience is required of the therapist. It is a virtual race between the growth processes of the cancer, and the locking-up processes of the cancer bed. If the rapidity of cancer growth occurs at a faster rate than the building of the prison by the elements of the cancer bed, the patient will succumb of his disease. On the other hand, if the cancer bed strangles the cancer by an excess production of fibrous tissue, and the cancer cells are starved by endarteritis and a diminished food and blood supply, then it follows that the disease must remain a local process. We have many cases with the complete scientific data to prove this point, cases that have remained "cured" or locally inert for many years.

The following three cases illustrate patients in whom the mammary cancer has been inactivated by proper irradiation therapy. Each one of these three cases has cancer cells present in the fibrotic mass. They have been present since commencing the original radiation therapy six years, six months six years six months, six years, four months ago. Experiences with such cases will eventually point the way to the ideal to be striven for in the irradiation therapy factors. One must not be discouraged by the fact that the microscopical studies reveal the presence of cancer cells, even though they be viable cells. Some observers have condemned the use of interstitial and external irradiation in the treatment of mammary carcinoma, because

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then microscopical studies show these cancer cells present, but this view-point is unjustified by the subsequent clinical course of these same patients, as the following cases illustrate

CASE I—R S, married female, of sixty-five years came to the Memorial Hospital December 18, 1924 (See Fig 1) The patient had noted this lump in the right breast for a period of a year It measured 3 by 3 by 2 centimetres No definite nodes palpable Chest plate negative for metastasis In brief, this breast received 900 millicurie hours by insertion of platinum radon needles into the breast tumor 3,000 millicurie hours by radium tray over the lesion Thirteen low-voltage X-ray treatments Eight high-voltage X-ray treatments

These treatments covered a period of three and one-half years No biopsy was ever made until March 20, 1931, when a Hoffman punch biopsy was taken The report of the pathologist was "carcinoma on the smear Confirmed on section Cells small, hyper-



FIG 1—R S Showing the carcinoma of the right breast which has been heavily treated by interstitial and external irradiation for a period of six years, four months

chromatic and look atrophic but capable of activity" The breast mass seems to be entirely inactivated clinically It has not seemed necessary to give more treatment since June, 1928, three years ago There is no evidence of metastasis Patient is in splendid general health, six years, four months, since commencing her irradiation regime, of both interstitial and external therapy

CASE II—M Z, female, aged sixty-two years, came to the Memorial Hospital, August 18, 1924, stating that she had a lump in the right breast the size of a walnut that had been present for four months In the upper outer quadrant of the right breast was a hard mass 3 by 2 by 2 centimetres The clinical diagnosis of cancer was made and treatment instigated Chest plate is negative The patient has a serious cardiac condition which contraindicates any operative procedure Her treatment consisted of Platinum radon needles inserted into the breast tumor for a total of 1485 millicurie hours Radium tray 2,800 millicurie hours over the lesion Gold radon seeds into the axilla for 943.2 millicurie hours Four low-voltage X-ray treatments Eight high-voltage X-ray treatments

On March 20, 1931, a Hoffman punch biopsy was taken which showed the presence of carcinoma Clinically there is a dense fibrotic mass that seems inactivated, and the

patient has received no treatment for the past three years. It is now six and one-half years since treatment was first begun.

CASE III—L. M., married female of fifty-one years entered the Breast Clinic of the Memorial Hospital, March 20, 1925. Since fourteen years of age has had a lump in the right breast. (See Fig. 2.) Has begun to grow and now measures 2.5 by 2.5 by 1.5 centimetres. There is suggestion of skin fixity. The mass is situated toward the tail of the right breast. X-ray of chest was negative for metastasis. The treatment consisted of the following: March, 1925, a high-voltage X-ray cycle of four treatments was given over the breast, axilla and supraclavicular space. August, 1928, two high-voltage X-ray treatments were given over the breast. January, 1929, two high-voltage X-ray treatments were given over the axilla and supraclavicular region. January, 1929, two radium packs, totaling 14,000 millicurie hours, were applied over the breast tumor. April, 1929, two radium packs, totaling 16,000 millicurie hours, were again applied over the breast tumor.

During March, 1931 (six years since entering the clinic), a Hoffman punch biopsy was made and the tissue revealed cancer present. The patient died in September, 1931,



FIG. 2—L. M. The arrow points to the cancer of the right breast.

of a stroke of apoplexy, her cancer having been under control, even though present, for a period of six and one-half years by external irradiation alone.

*Statistical Studies*—The study herein reported is based on a survey of 199 operable cases treated at the Memorial Hospital during the decade January 1, 1916, to January 1, 1926. This group by no means represents the total number of operable cases that came to the clinic during those ten years. It does, however, represent all the operable cases on which full and complete data are available. Each case reported has had a microscopical study made of the tissue so that there is no question as to the exact nature of the neoplasm.

It is a great pity that many of our operable cases (not included in this report) treated by irradiation alone have had to be excluded because of the fact that no microscopical studies were made. Complete information on this group is especially desired. However, this was deliberately done at the

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time, following out the suggestion of Ewing that a larger number of operable cases treated by irradiation only would survive the five-year period if *no* biopsy were taken at first. The procedure of cutting directly into the tumor opened many lymphatics and blood-vessels for the free entrance and dissemination of the cancer cells. With the new method of biopsy by aspiration and small punch, the latter wound of which is immediately electro-desiccated, the danger of dissemination is minimized. Today we obtain a microscopical report in nearly every case. Many of the operable cases treated by only irradiation methods have gone on to a "five-year cure", but inasmuch as there is no microscopical study made on these cases, this group is eliminated from consideration as but few would have the generosity to accept the report.

Likewise, there is a group of operable cases treated by irradiation methods only that have died of unquestioned clinical carcinoma—but as there was no microscopical study, they are similarly excluded from this study. The latter two groups are not herein reported as it would be obviously unfair to report the one group without the other. We repeat that this study is strictly confined to those cases regarding whom complete data are available for a period longer than five years.

To facilitate this study, the 199 cases are grouped into four series, as follows:

TABLE I

### *Series A*

115 Cases—Either Dead or Lost

	Cases
Treatment by surgery (only)	18
Treatment by irradiation (only)	21
Treatment by combined irradiation and surgery	76
	<hr/>
Total	115

Of these 115 cases, we know that at least six lived five years or more

### *Series B*

66 Cases—All Now Living Over Five Years

	Cases
Treatment by surgery (only)	2
Treatment by irradiation (only)	12
Treatment by combined irradiation and surgery	52
	<hr/>
Total	66

### *Series C*

16 Cases—Dead of Intercurrent Disease

	Cases
Treatment by surgery (only)	3
Treatment by irradiation (only)	4
Treatment by combined irradiation and surgery	9
	<hr/>
Total	16

Of these sixteen patients, nine lived more than five years

## Series D

2 Cases—Very Young Subjects Living Without Disease

	Cases
Treatment by surgery (alone)	0
Treatment by irradiation (alone)	0
Treatment by combined irradiation and surgery	2
	<hr/>
Total	2

No case in the above series A, B, C, and D, has been studied for less than five years, some have been followed as long as twelve years

*Series A*—Series A comprises those 115 patients either known to be dead or about whom we have been unsuccessful in our efforts to obtain any information. For the purpose of these studies we assume that the lost cases are dead. We realize that there are probably some who are cured but cannot prove it. Eighteen patients (15.5 per cent) of Series A were treated by surgical methods only, without irradiation being employed as an adjunct.

When it is stated that a case was treated by "irradiation only," it is meant that the attempt *to cure* has been by the employment of one or more of the irradiation methods. Up to the present but little success has attended the attempt to cure mammary cancer by the application of *external irradiation* by X-rays and radium packs. Unquestionably, there is an occasional case cured by external irradiation, but that method cannot be relied on with our present technic for the cure of such a normally radioresistant tumor. On the other hand, we are testing the combined use of *interstitial* (insertion of radon into the tumor and surrounding areas) and *external* irradiation. In order to cure a radioresistant cancer such as the fibrocarcinoma, it is often necessary to give such large quantities of interstitial and external irradiation that marked skin damage results and a simple mastectomy becomes necessary. Or it may be necessary to employ surgery for the *late* effects of irradiation of the skin. In either instance, the patient is still considered to remain in the irradiation group. We regard such a case as one that is being treated by irradiation methods, but that it is necessary to employ a surgical procedure to treat the irradiation complication. Should this same patient *not* survive a five-year cure, the failure is charged against irradiation methods and *not* against surgical methods. On the other hand, if treatment has resulted in a five-year cure the success is accredited to irradiation. In other words, the success or failure of the treatment is attributed to that method along which the original line of therapy was laid down. There were twenty-one patients (18.1 per cent) treated by irradiation alone in Series A.

By the combined irradiation and surgery method we mean that the patient is first treated by a pre-operative high-voltage X-ray cycle consisting of two treatments over the breast tumor and one each over the axilla and the supraclavicular space. Approximately a month following the last of these four treatments the radical amputation is performed, one month later the post-operative X-ray cycle is begun over the operative area, the axilla and the supraclavicular space. Unless the post-operative treatments are given within

eight to ten weeks following the operation, it should not be properly considered a "post-operative cycle"

It occasionally happens that one believes himself to be dealing with a benign lesion only to find at the operating table that it is a malignant tumor. This tumor has received no pre-operative irradiation but following the operation the patient receives the post-operative irradiation and hence is still considered to be in the group of combined irradiation and surgical treatment. Furthermore, if interstitial irradiation is employed instead of or accompanied by external irradiation, and surgery is later employed, the case is considered to be in the group of *combined irradiation and surgery*. In Series A, there were seventy-six cases (66 per cent) treated by the combined method.

*Series B*—Series B is composed of sixty-six living patients, no one of whom has been treated or observed for a period of less than five years. In Memorial Hospital it is but the rare case treated by surgery only. Those thus treated are usually not deliberately so done but they represent instances of difficult or frankly mistaken diagnosis. In Series B there are only two such cases (3 per cent). There are twelve cases, or 18 per cent, of Series B treated by irradiation methods only, and fifty-two cases (79 per cent) treated by the combined irradiation and surgical method.

*Series C*—Series C comprises sixteen patients, of whom twelve died of some intercurrent disease, while four could not be traced. The reason for this large number of deaths from diseases other than cancer is the advanced age of the patients. Seven of the sixteen patients were very old, their ages being respectively ninety, eighty-five, eighty-four, seventy-nine, seventy, seventy, and sixty-nine years. The deaths were chiefly from heart disease and pneumonia, the terminal disease groups so prevalent at these advanced ages. All but four either died or were lost without clinical evidence of cancer. The four patients (25 per cent) who died of intercurrent disease having clinical cancer present, were aged eighty-five, seventy-nine, sixty-nine and ninety years respectively. In no one of these four patients was cancer an important contributing cause of death. Nor was it considered to be particularly menacing in any of these elderly patients. In Series C, surgery alone was employed in three patients (19 per cent), irradiation alone in four (25 per cent) and combined irradiation and surgery in nine patients (56 per cent).

In elderly people it is commonly a question of fine judgment as to the best type of management. If the patient is aged seventy-five years or older, the best procedure is to disturb the patient as little as possible. If there is an impending ulceration of the overlying integument, it is better to entirely withhold irradiation. If no ulceration is imminent, only *divided* irradiation doses should be employed. In the older people even the excoriation of the skin should be carefully avoided as they do not well withstand the pain of the irradiation burn, nor do they well endure the gastro-intestinal upset of irradiation. One hopes to avoid a breaking down of the tumor. If the aged patient has a tumor present which is commencing to ulcerate, it is often best



to perform a simple and quick mastectomy *under novocaine* anæsthesia and promptly get them out of bed following their operation. With a little assistance from irradiation or the simplest type of surgery, the patient will frequently go on for years without distressing symptoms from metastasis, and may then die from an intercurrent disease. Of the sixteen cases of Series C, nine are five-year successes. Seven died of intercurrent disease before the five-year period was up, but not one of the sixteen cases died of cancer. Four patients did, however, have cancer *present* at the time of death. In the elderly cancer patient, judicious management is all important.

*Series D*—Series D is composed of two cases only. It is a rare and interesting group in which we are dealing with cancer of the breast in the *very young* subject. One patient was aged seventeen years and the other aged nineteen years. Both patients had cancer present. They would be included in cancer statistics as cures. Doctor Ewing, our pathologist, diagnosed each specimen as "carcinoma" but qualified his diagnosis by stating that "although each is microscopically malignant, the case is clinically benign." This opinion he based on the rarity of the areas where infiltration and invasion had occurred, and on the fact that the lesion is sharply circumscribed and thoroughly encapsulated. Some of the ducts were filled with definite cancer tissue while other ducts retained their normal or adenomatous form. It is a very localized cancer process. Sir Lenthal Cheate considers this group as definitely carcinomatous, while Ewing, on the contrary, considers the process benign on account of the youthfulness of the patient, the encapsulation, and the fact that the process is only beginning to invade the basement membrane.

These two cases are being excluded from our true cancer series for the above reasons. After deducting them from the 199 original cases, the number in our study is reduced to 197.

Both of these young patients were treated by a local removal of the tumor, followed by implantation of radium in and about the wound, and this was later followed up by the employment of radium packs and high-voltage X-ray over the local and drainage areas. Both patients are free of disease, one for seven years three months, and the other seven years.

The following table (Table II) shows the proportion of the methods of treatment employed in relation to the 197 cases.

TABLE II  
*197 Patients Treated Five Years or More*

	Irradiation (only)	Surgery (only)	Combined surgery and irradiation
Series A	Cases 21	Cases 18	Cases 76
B	12	2	52
C	4	3	9
Totals	37 (19%)	23 (11 7%)	137 (69%)

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Ninety-one of the 197 cases lived five years or more, this being 46 per cent of our total series. Table III presents these according to group and number of years lived.

TABLE III  
*Lived Five Years or More*

Years	5	6	7	8	9	10	11	12
Series A 115 cases	16	9	1	1	0	1	0	0
Series B 66 cases	66	15	6	8	6	8 (12%)	1	3 (5%)
Series C 16 cases	9	2	0	1	0	0	0	0
Total	91							

Total, ninety-one cases (out of 197 cases) = 46 per cent

The next table (Table IV) gives the method of treatment and the results of each method in the series of 197 cases.

TABLE IV  
*Treatment Results Five Years*

	No	Died other disease	Basis of calcu- lation	Num- ber living	Per cent living	Died of cancer	Per cent	Living with disease	Per cent	Living without disease	Per cent
Surgery (alone)	23	3	20	2	10	18	90	0	0	2	10
Irradiation (alone)	37	4	33	12	36 3	21	63 3	4	12 1	8	24 2
Combined surgery and ir- radiation	137	9	128	52	40 6	85	66 4	3	2 3	49	38 2

The basis of calculation was arrived at by deducting from the total number of cases treated by the respective methods the number who died of intercurrent disease. Those cases treated by surgery alone in this series seem to be particularly unfortunate, as there were only 10 per cent of them living at the end of five years. There were thirty-seven cases treated by irradiation alone, four died of intercurrent disease, twelve are living, making 36 3 per cent, four are living with disease, and eight, or 24 2 per cent are living without disease. *The important point of this group is that 36 3 per cent treated by irradiation methods alone are living over five years.* The fact that four patients of these twelve have disease present is probably not nearly so important since irradiation is the method of therapy being employed. *Of those treated by a combined surgical and radiation method, fifty-two (40 6 per cent) have lived over five years.* Three of these patients have disease present.

and forty-nine patients (38.2 per cent) have no clinical evidence of disease. In other words, the five-year result by irradiation treatment (36.3 per cent) is interesting when compared with the combined surgical and radiation method (40.6 per cent). This figure, 36.3 per cent, is an important one for the general medical man to know because it lends more than a ray of hope for the operable case in whom operation is contraindicated by the presence of other diseases. The likelihood of a five-year cure by radiological methods approaches those results obtained by the radical amputation and radiation treatment combined.

It is of further interest to note that there is a marked difference between those patients treated by the combined method (38.2 per cent) and the irradiation method (24.2 per cent) as concerning the presence of disease. However, I believe the 24.2 per cent is low because the patients may have the disease present and still have the carcinoma inactivated and the process completely stopped. It will require observations covering a period of ten or twelve years to settle the relative long-run value of these two methods.

Doctor Lee,<sup>5</sup> three years ago in a survey of five-year results at the Memorial Hospital, after studying the relative value of pre-operative irradiation and post-operative irradiation, came to the following conclusion:

TABLE V  
*Results in Primary Operable Patients*

	No	Alive well	Alive recurrent	Dead	Dead of intercurrent disease	Lost track	Per cent five year results
A Pre-operative irradiation, surgery, post-operative irradiation	41	14	1	24	3 (after five years)	0	39
B Surgery, post-operative irradiation	76	25	0	49	0	1	35
C Irradiation	45	11	1	22	6 (after five years)	5	36

In Doctor Lee's study of the 162 operable cases mentioned in Table V, there is a 4 per cent better result in those forty-one cases having the advantage of pre-operative irradiation over those who had only the post-operative irradiation. In my series of 128 cases, the combined method gives 40.6 per cent five-year cures which is 1.6 per cent higher than the series reported by Lee. This may possibly be explained by the fact that in my series, which is more recent, a larger proportion were treated by the *high-voltage* X-rays, rather than the low-voltage.

It is interesting, also, that Doctor Lee's studies of those cases treated by

## RESULTS OF TREATMENT OF MAMMARY CARCINOMA

irradiation methods only are almost identical with mine (36 per cent and 36.3 per cent respectively)

*Biopsy*—Mention must here be made of the newer methods of obtaining biopsy material in those cases where diagnosis is difficult. Even in the hands of those clinicians who possess a large experience in the diagnosis of breast lesions, there will always remain a group which is clinically impossible to diagnose. The aspiration biopsy methods of Guthrie,<sup>6</sup> of Martin and Ellis,<sup>7</sup> and the punch technic by Hoffman<sup>8</sup> add greatly to the ease of diagnosis in this difficult group. Incidentally, the surgical technic is quite simple. The *important factor* is the pathologist, who should possess a large experience in the interpretation of such pathological material. By the use of these methods one may have a microscopical diagnosis within ten minutes. Valuable time will be saved, the patient will be spared a bigger biopsy procedure, and the danger of the usual biopsy will be minimized.

### RESUMÉ

(1) A study is made of 199 primary operable cases of mammary carcinoma on whom complete data for a period of no less than five years are available.

(2) On account of the importance of the debilitating diseases other than cancer, which diseases contraindicate radical surgical procedures, special examination is made of those cases which were treated by irradiation methods.

(3) Standard radical mastectomy in the good general hospitals of America yield from 32 to 39 per cent five-year cures.

(4) The author's criteria of operability are discussed.

(5) Obtaining a "five-year cure" by irradiation methods is accomplished along totally different lines than that by a surgical procedure. The latter is by a wide extirpation of the breast, its contiguous structures and its drainage basin, while the irradiation "cures" are produced by locking up the local disease in dense fibrous tissue, and starving the disease process by endarteritis, and the direct insult to the cancer cell which is produced by the rays.

(6) It is believed that external irradiation alone by radium packs and high-voltage X-rays is, as a rule, not sufficiently potent therapy to effect cures in mammary cancer. We consider breast carcinoma to be a relatively radio-resistant form of cancer.

(7) Most cases of "cures" by irradiation have been accomplished by the combined interstitial insertion of radium together with external radium packs and high-voltage X-rays.

(8) Of the thirty-seven cases treated by irradiation methods only four died of intercurrent disease, twenty-one died of cancer, and twelve, or 36.3 per cent, are living over five years.

(9) Of the 137 cases treated by the *combined* irradiation and surgical method, nine died of intercurrent disease, eighty-five died of cancer and fifty-two, or 40.6 per cent, are living over five years.

(10) These improved results (40.6 per cent) we rightly or wrongly deem to be due to the added factor of irradiation

CONCLUSIONS—Irradiation, if properly applied, can be relied on to effect a “cure” in cases of mammary cancer, in 36.3 per cent. It offers a substitute weapon but slightly less effective in five-year results than the combination of irradiation and surgery (40.6 per cent). In cases where surgery is contra-indicated the combined interstitial and external irradiation is our most efficient agent

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# STEREOSCOPIC RONTGENOGRAPHY OF THE BREASTS

AN AID IN ESTABLISHING THE DIAGNOSIS OF MASTITIS AND CARCINOMA

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CLINICAL evidence is often inconclusive concerning the character of an abnormal mass palpated within a breast of a patient at the cancer age. The differentiation of a chronic mastitis from early carcinoma, especially of the scirrhous form may be most puzzling or impossible. It is the recognition of this fact which has led investigators to seek other means for this early differentiation such as transillumination by Cutler (1929)<sup>1</sup> and radiography by Warren (1930)<sup>2</sup>

The latter method consists in taking stereoscopic roentgenograms employing a technic to bring out detail of the soft tissue of the breast, the subpectoral muscles, the axillary fossa, and adjacent ribs. We wish to emphasize certain differential characteristics between chronic mastitis and early carcinoma which have been found reliable after further experience with this method of examination.

Cutler has found that transillumination has certain definite limitations. These are in part of a mechanical or physical nature. In the large non-pendulous breast closely applied to the chest wall, it was found impossible to place the lesion between the source of light and the eye of the observer, and there was a real danger of missing small solid tumors located near the surface of the breast due to the diffusion of light. Of greater importance than these which permit correction or improvement in technic is his finding that it was impossible to differentiate between a benign and malignant tumor of the breast even under optimum working conditions.

In carrying out our work the roentgenological examination appears to us to have the following advantages over transillumination. (1) It is possible to determine encapsulation of tumor. (2) Transillumination permits no analysis of structure within a mass while it is this analysis by roentgenological examination which permits the differentiation between chronic mastitis and malignancy. It is this differentiation which constitutes the chief confusion clinically. (3) Transillumination gives no information concerning deeper structures while the roentgenological examination gives data concerning the involvement of the pectoral muscles, ribs, and axillæ. It is this kind of evidence (of metastatic invasion) which determines the type and course of treatment. (4) By transillumination it is not possible to recognize such changes as calcification which is readily determined by roentgenography. (5) Roentgenological examination has the advantage of stereoscopy. (6) It also constitutes a permanent record permitting future comparison by



FIG 1—Normal obese breasts R. H., married, forty one years of age, and without significant history relative to breasts. While these breasts are large and heavy their physical size does not change the general roentgenological appearance of the normal breast. The presence of a large amount of fat, permits sharp definition of breast pattern, particularly of the fibrous septa of the breast. The band of increased density crossing the right breast represents a part of the patient's clothing.



FIG 2—Diffuse mastitis of both breasts with cysts. E. M. housewife of fifty eight years, has a history not pertinent to breasts and a physical examination of the breasts was reported negative. Roentgenological examination showed numerous compact masses (A) resembling cysts. Note the lobular appearance of these masses, their smooth margins, and the absence of infiltration and skin involvement. Base (B) of the breast is free, no evidence of metastases. In spite of the extensive pathology of these breasts, the clinical examination failed to detect any changes.

## RONTGENOGRAPHY OF THE BREASTS

serial roentgenographical study and in this regard is of help in establishing the prognosis during the course of irradiation or other treatment

Fig 1 illustrates the normal breast structure of an obese individual. The presence of a large amount of fat in a heavy breast constitutes a definite handicap in the identification of masses by physical examination. The physical size of the breasts, however, does not prevent a satisfactory radiographical examination, in fact, the presence of fat serves as a tissue of contrasting density which permits the delineation of opaque masses within such breasts.

In working out the differentiation of mastitis and carcinoma, it is well to carry the gross pathological picture in mind. Mastitis in the true sense is an inflammatory reaction in either the acute or chronic state. Often both

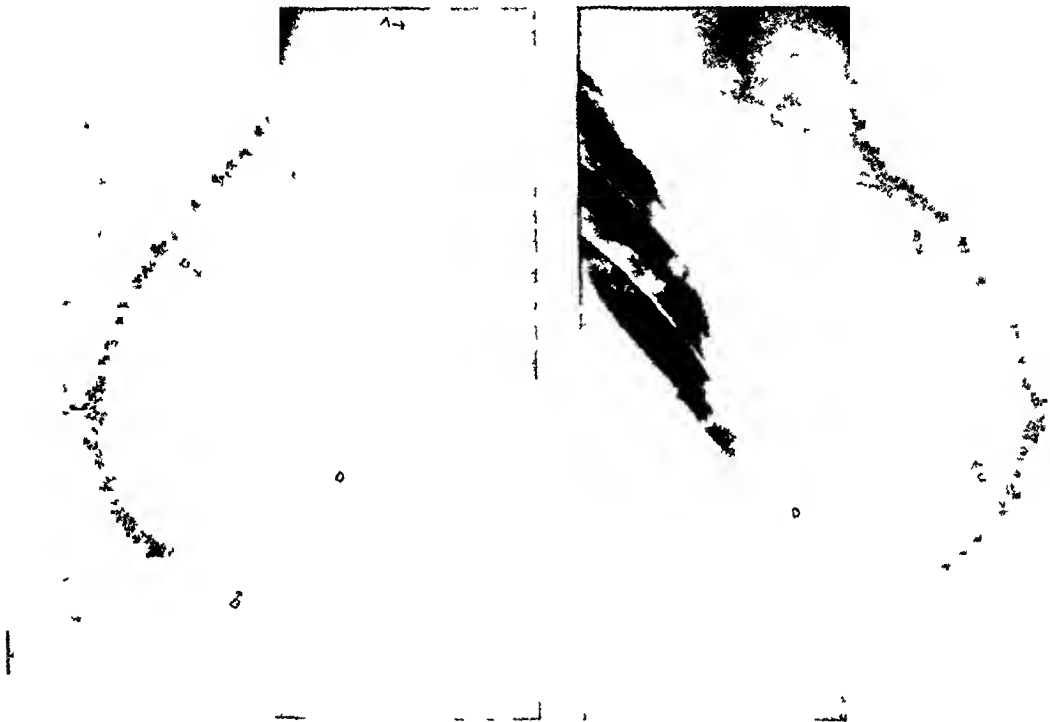


FIG 3—Acute and chronic mastitis in an obese breast. Patient was a virgin of fifty-eight years, with a two months' history of transient recurring pain in both breasts. Physical examination demonstrated the presence of tender masses within the breasts. There was no discharge from the nipples. Films show an old coarse fibrosis (C) with superimposed soft, acute changes (B). Note that in acute mastitis the glands of the axilla (A) may be considerably enlarged. The preservation of the breast pattern and absence of pectoral involvement at (D) is against carcinoma.

stages are present together. In the gross cross-section, one can visualize the course of histological changes which ensue. Edema with associated swelling or distortion of structures, infiltration of cells, beginning repair, contraction and scarring, the obstruction of a duct or part of an acinus with dilatation and formation of a cyst, often a certain amount of hyperplasia and thickening of the glandular tissues which is thought at times to result in the formation of a malignant condition.

The gross structure of the breast with the denser duct and glandular structures interspersed among the fat lobules (which are more radiotranslucent) is such as to show these pathological changes in much the same fashion as inflammatory changes show up in the lungs. Acute changes are



soft, feathery, indistinct, and diffuse, while the more chronic changes are dense, sharp, distinct, and more compact due to the connective tissue changes. Both acute and chronic changes may occur side by side with all gradations between. Cysts are identified from fat lobules by their greater density and sharp outline, usually occurring in the region of the ducts. Cellular masses are much denser, their density depending on the type of cell. Through all these changes a definite architectural pattern typical of the breast can be made out.

The gross appearance on cut-section of carcinoma is characterized by a hard, dense tumor infiltrating the normal structures in all directions. This



FIG. 4.—Chronic mastitis with cysts. A F, married woman of forty-four years gave a history of removal of tumors from breasts fifteen years before admission. Biopsy report stated that masses were benign according to patient's statement. Physical examination revealed palpable mass irregular in outline in right breast. Films of breasts showed a very diffuse process with much fibrosis (B) due to mastitis with cyst formation. The right breast is deformed by a scar (A) of old operation. This case has been followed two years without evidence of malignancy.

is accompanied by an extensive connective tissue reaction with a tremendous shrinkage and distortion of local structures which have been infiltrated. This is noted even in small tumors when examined pathologically.

This tumor mass presents essentially the same picture when examined by stereoscopic roentgenograms. A compact mass with indefinite periphery due to the infiltrating invasive tumor and a dense connective tissue reaction is noted which displaces and deforms the normal architecture of the breast.

Contrasting these two roentgenological pictures (mastitis and carcinoma) the following differential features are to be noted:

- (a) Carcinoma finds its origin in a single area or focus within one

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breast (Fig 5) In mastitis, on the other hand, there are characteristically multiple points of origin and often both breasts are involved Early carcinoma is practically never found in both breasts simultaneously, and even later, when involvement of both breasts may occur, the original tumor is larger than the metastasis and at this late stage metastatic invasion along lymph channels is clearly evident on the most cursory perusal of the films

(b) Carcinoma forms a compact mass with an indefinite periphery (Figs 5 and 6) while mastitis produces a very diffuse mass (Figs 2, 3, and 4) which shades off imperceptibly to the normal structures peripherally

(c) Scarring (reparative fibrosis), (Figs 3 and 4), which is so common

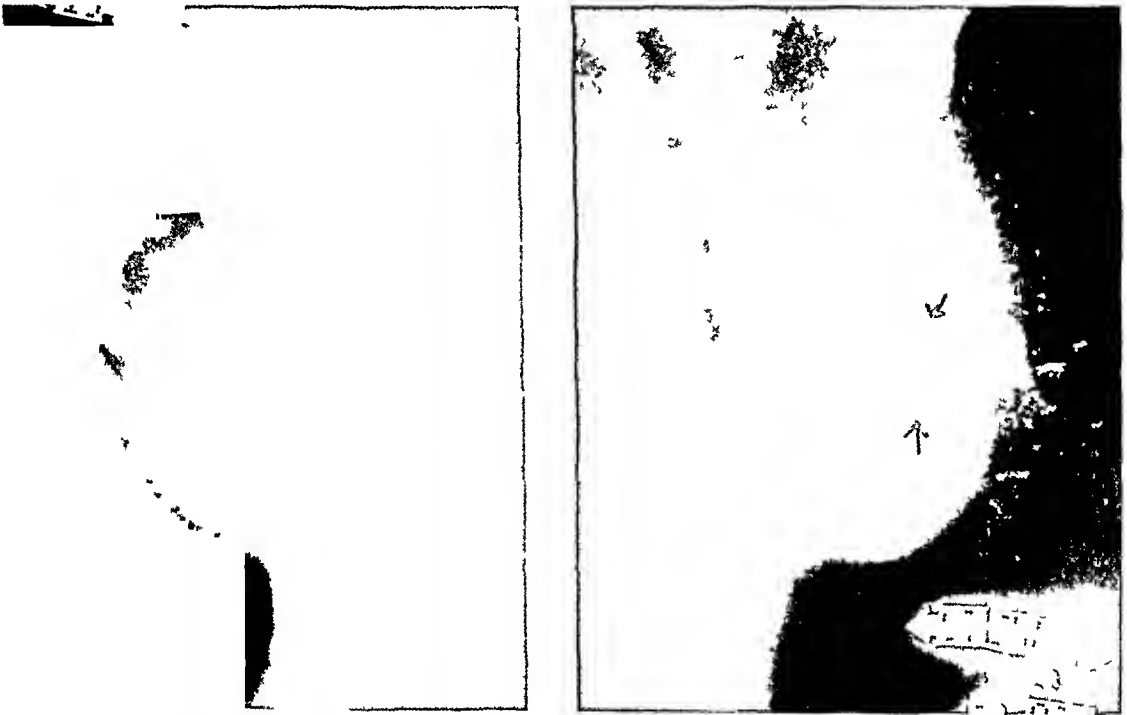


Fig 5—Early carcinoma of left breast L. D., single woman of fifty four years first felt lump four years ago in left breast, no discharge from nipples There is history of artificial menopause nine years ago Rontgenological examination showed right breast normal The left breast showed a small area of dense tissue with irregular margins in upper portion of the breast A very early carcinoma was considered likely in view of the character of the mass The axillary regions are not well seen The clinical diagnosis was chronic cystic mastitis However at operation a short time later, radical breast operation was done because of the appearance of the cut section of the mass (thought to be early carcinoma) *Pathological report*—Mass the size of a walnut, gray in color, irregular in outline with numerous strands extending out into surrounding tissue Microscopic section showed scirrhous carcinoma Intensive radiation given for several years, no evidence of recurrence during course of four years following operation Note the irregular border of mass and its single character Its early status is reflected not only by its small size but in the absence of macroscopic involvement of pectoral muscles

in chronic mastitis, results in no massive distortion of the normal breast architecture The scarring (infiltrating fibrosis) of malignancy (Fig 6) grossly distorts this architectural breast pattern This is especially true of the scirrhous type

(d) The thin septum between the breast structure and the pectoral muscles is never destroyed in mastitis (Figs 2 and 3) while in carcinoma (Fig 6) invasion often results in its destruction at the site of the mass

(e) The presence of large nodes (Fig 6) and other metastases serve to identify a late carcinoma of the breast

At times it is possible to obtain clues concerning the type of breast malignancy. Thus (a) a scirrhous carcinoma produces much more distortion of the breast pattern than a medullary carcinoma. (b) The latter often produce considerable bulk resulting in a marked disproportion in the size of the breasts. (c) Serial films demonstrate the more rapid growth of the medullary type. (d) Early evidence of local metastases is common in this latter type. It is frequently noted, however, that malignant tumors may show all degrees of variation from a predominant sclerosis to one with very little connective tissue reaction and classification into types before operation becomes impossible or hazardous.

Mastitis is an extremely common lesion. A certain amount of scarring as a result of inflammatory reaction is present in many women (in both nulliparous and multiparous women). The degree of involvement varies tremendously and seems to bear no relation to the size or shape of breasts, age of patient after full development of breast, or the number of lactation periods. Lactation may leave few scars or other changes while a middle-aged woman with no clinical history of inflammatory changes at lactation occasionally shows most marked changes in the density of the periglandular or ductular portions of the breast. In the identification of this lesion, changes due to menstruation, lactation, atrophy, shrinkage due to loss of weight, and changes due to involution must all be borne in mind as complicating factors.

With proper precautions and careful follow-up, a diagnostic precision of considerable accuracy can be obtained. It is often impossible to identify or rule out an early scirrhous carcinoma in the gross section when it is enmeshed in a dense area of mastitis. Microscopical study often is necessary to prove its presence or absence. In the case of very small tumors (5 to 10 millimetres in diameter) which are buried in a mass of inflammatory change, the identification of the tumor may be impossible with the present technic. Repeated examination, however, should reveal the tumor before the diagnosis can be established by clinical means. Present-day practice is of course to perform a mastectomy if there is a possibility of malignancy being present. This method of serial roentgenographical study should open up a new means of following all cases in which the evidence is insufficient to justify operation but where the exact diagnosis remains doubtful.

As regards results, correct diagnoses have been made in 85 to 90 per cent of cases coming to operation. This work was done as a routine procedure without knowledge of the final diagnosis. Of the group having palpable breast masses classified by means of this method as mastitis, and eliminated from the malignant group, none have developed a malignant tumor during approximately four years of observation. To extend the experience and accuracy of the roentgenologist, it is most important to secure the co-operation of the surgeon and pathologist in order that every breast examined can be followed up. Films of the specimens removed at operation should

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be taken. The gross specimen should be examined with the pathologist comparing its pathological picture with the rontgenological densities.

Aside from the value of this method as an aid to diagnosis, the rontgenographical examination can play an important part in establishing the prognosis. The extent of the tumor can be traced out and the manner of its spread through the base along the lymphatics through the pectoral and axillary lymph-nodes or through to the pleura can be established. Involvement of these channels is of extreme importance in determining the feasibility of mastectomy with block dissection. The recognition of extension into the pleura changes the prognosis of a case, which from the clinical viewpoint with no other evidence of metastases appeared favorable for opera-

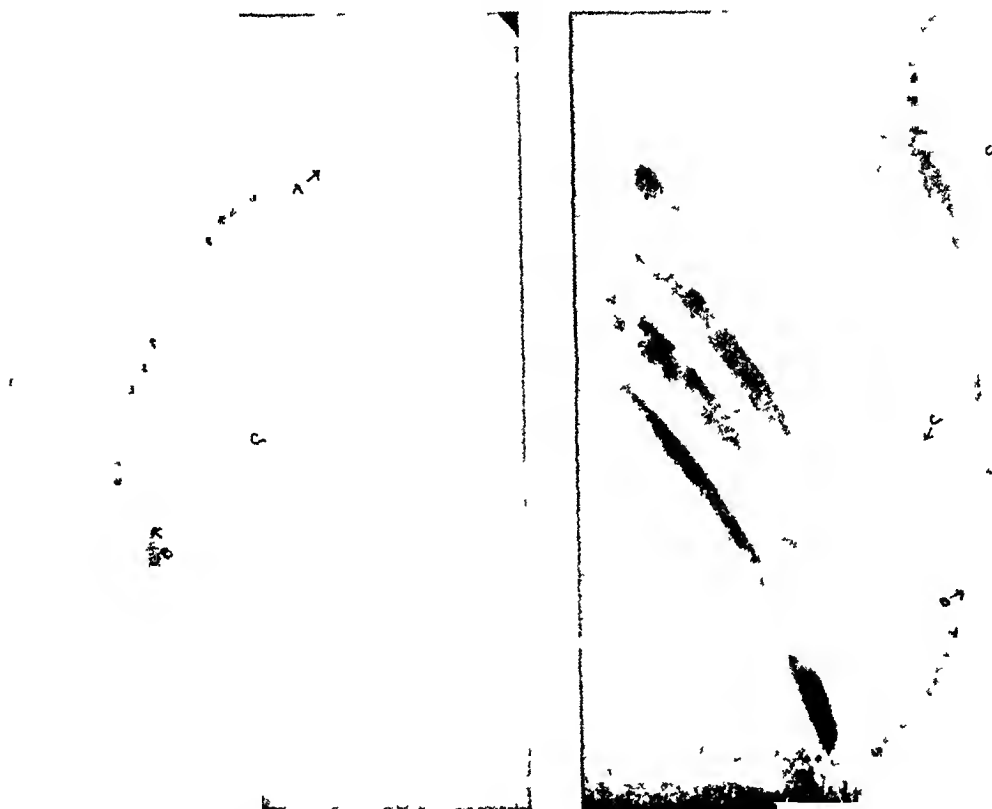


FIG 6—Advanced breast carcinoma. C A, housewife of fifty six years, gave a history of a mass in the right breast, first noted two years before admission. This was followed by similar involvement of left breast. Physical examination showed visible and palpable tumors of both breasts. Rontgenological examination showed adenocarcinoma of breasts with ulceration and invasion of pectoral muscles and axilla. Films of spine showed evidence of metastatic invasion with collapse of fifth cervical vertebra. Under deep therapy, the masses in the breast decreased in size. Also, some repair occurred in the collapsed cervical body. Note absence of septum between base of mammary gland and pectoral muscles as well as masses (C) within breasts and dense infiltration at skin surface (B). There is a large node in the right axilla at (A).

tion, to an unfavorable one. It is unusual for the axillary nodes to be involved without some evidence of the spread being obtained from the films. The extent of this involvement should be known to the surgeon so that he may include an area well beyond it in the dissection. Many tumors recur because the surgeon is unable to determine accurately the exact extent of the metastatic invasion at the time of the operation, and any method which will fortify him and impart to him the extent of his task will aid the patient and surgeon alike.

*Summary*—The differential diagnostic rontgenographical features of mastitis and carcinoma which have been found helpful in this clinic are discussed. It is believed that this method imparts information not obtainable by other means known at the present time. Besides its diagnostic value, the method is of definite aid in establishing the prognosis before treatment and subsequent serial rontgenographical study will give important information concerning the response to treatment (as irradiation, *etc.*). It may not be amiss to add that this method is not offered as a substitute for or to replace any portion of the physical or other examination. The physical examination of the breast cannot be too exactly carried out. The rontgenographical examination should serve, however, as a valuable supplement in establishing both the diagnosis and prognosis.

**CONCLUSIONS**—(1) Most of the gross pathological changes in the breast are as readily identified in stereoscopic rontgenograms as they are in the gross specimen at biopsy or autopsy.

(2) Stereoscopic rontgenograms of the human breast offer many advantages in establishing the diagnosis in suspected cases of malignancy, not obtainable by clinical methods.

(3) The earliest changes due to scirrhus carcinoma in the presence of a chronic mastitis are as difficult to identify as they are in the gross specimen.

(4) In addition to the diagnostic aid which this method offers, valuable information can be obtained concerning the prognosis before treatment.

(5) Serial study is of great importance in following doubtful cases and cases under irradiation treatment.

(6) Cooperation between the surgeon and the radiologist is essential if the diagnostic accuracy is to be maintained at a high level.

An appreciation is due from us of the cooperation of the members of the medical and surgical staff of the Strong Memorial Hospital who have referred these cases to us for study and who have given us every facility for keeping them under observation. The assistance of the pathological department also has been very great and continuous.

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# SARCOMA OF THE BREAST

## A REPORT OF SEVEN CASES

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SARCOMA of the breast is a rare disease, as is shown by examination of the records of all tumor cases admitted to the State Institute for the Study of Malignant Disease. From 1913 to November 1, 1931, there was a total of 11,490 tumor cases, 9,540 of which were malignancies. Of the total number of malignancies, 8,703 were of epithelial origin, and 749, or 7.8 per cent, were of connective-tissue origin of sarcoma, and eighty-eight leukemias. Of the 749 sarcomas, only seven, or 0.9 per cent, were in the breast, of the 1,395 malignancies of the breast, only 0.5 per cent proved to be sarcoma. Of 1,837 breast lesions, 75 per cent were carcinomas, 0.38 per cent sarcomas, 22 per cent benign tumors and cysts, 1.2 per cent inflammatory lesions, and 0.38 per cent tuberculosis. There were 1,383 carcinomas, including sixteen Paget's disease, two epitheliomas of the skin of the breast, three naevus-cell carcinomas of the skin, seven sarcomas, 407 benign tumors and cysts, twenty-three inflammatory lesions, seven tuberculosis, four anomalies, and one traumatic lesion.

D'Aunoy and Wright,<sup>1</sup> in 1930, collected the reported cases of sarcoma of the breast since the tabulation by Geist and Wilensky<sup>2</sup> in 1915. These figures, together with our seven cases, bring the total to 510.

Deaver and McFarland,<sup>3</sup> in 1917, made a rather exhaustive study of the literature and tried to classify the types of growth from the histories and data given, but confessed that it was extremely difficult to do so. They called attention to the fact that the generation of surgeons and pathologists in the last half of the nineteenth century reported a great many more cases of sarcoma of the breast than the present generation. They suggested that this may be due to the present refinements in histological diagnosis.

These tumors begin as isolated, rounded or lobulated nodules, solid and cystic tumors are also observed. The cystic forms produce exceedingly large tumors as are shown in Figs 1, 2, and 3.

Ewing<sup>4</sup> calls attention to the fact that if many of the tumors that are called adeno-sarcoma and sarcomacarcinoma were eliminated, there would be fewer cases of true sarcoma of the breast. The types of sarcoma described are round-cell, spindle-cell, adeno-sarcoma, mixed tumors showing fibrosarcoma, myxosarcoma and osteosarcoma. Quoting Gross, Schmidt and Schuoler, he states that adeno-sarcoma forms about 7 to 10 per cent of the breast neoplasms, that adeno-sarcoma represents the malignant form of adeno-fibroma, but that adeno-sarcoma when recurring often produces pure spindle-cell sarcoma. "In the early stages, the tumors are circumscribed or encapsulated, but active growth leads to dissemination through the organ, and fungating masses perforate nipple and

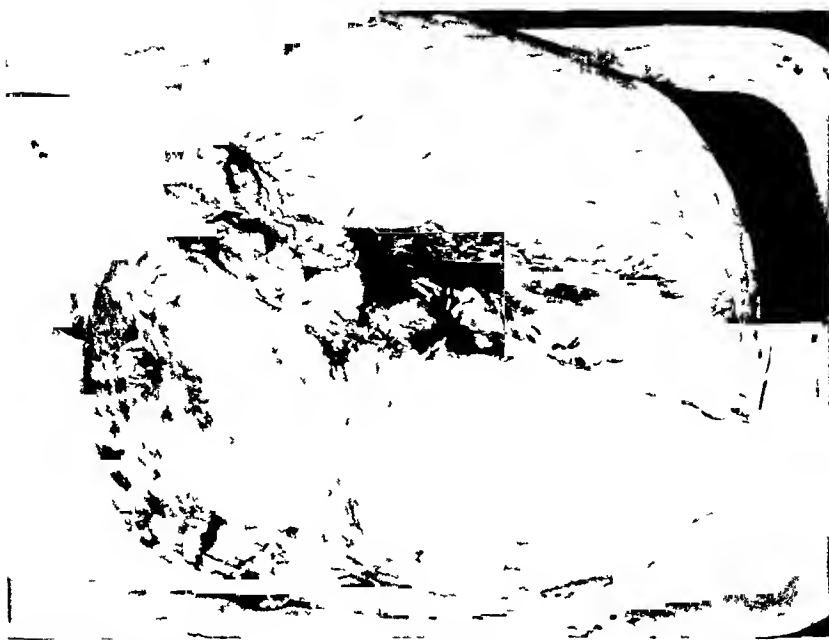


FIG 3.—Photograph of specimen Case VII, after removal of the breast

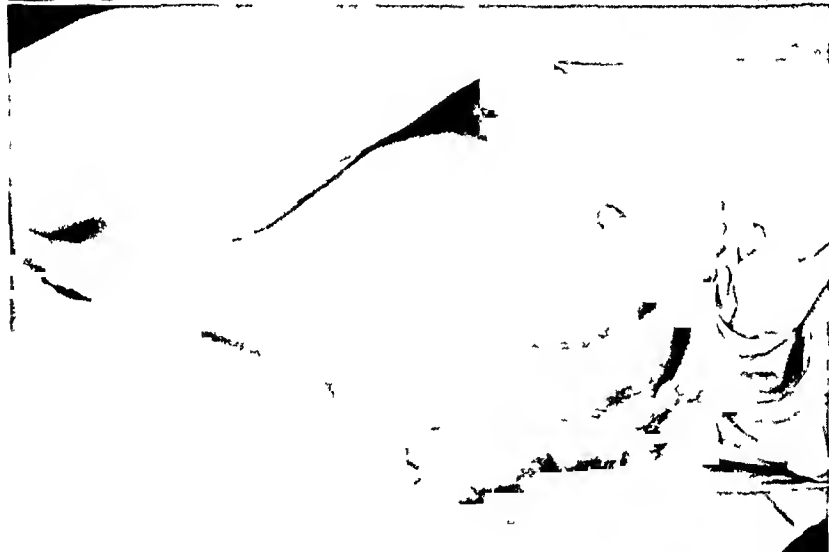


FIG 2.—Photograph of Case VII on admission



FIG 1.—Photograph of Case III on admission

## SARCOMA OF THE BREAST

skin with ulceration. Œdema, hæmorrhage, necrosis, and suppuration complicate the advanced stages. In some cases myxomatous changes and overgrowth of blood-vessels are prominent."

Ewing also states, "Labbe and Coyne early pointed out that nearly half the cases represent a malignant transformation of a long-standing fibro-adenoma, and that gestation, lactation, and trauma appear to be exciting causes of the change." In our seven cases there was no history of injury, lactation or recent gestation. One of our cases (Case VI) gave a history of a tumor of forty years' duration.

It is not the purpose of this paper to enter into the discussion of the histopathology, which may or may not be controversial, but to record these seven cases. It was thought that a brief résumé of these histories, pathological findings, together with the treatment and end-results, would be of interest.

One of these cases occurred in a male, seventy-seven years of age, the other six were in females, thirty-two, fifty-seven, fifty-eight, sixty-five, sixty-



FIG. 4.—Photomicrograph, Case I, lymphosarcoma, showing invasion of muscle.

nine, and seventy-eight years of age. Gross observed a case as young as nine years, another as old as seventy-five years, the average age is reported as between thirty and fifty years.

CASE I—A woman, aged sixty-nine years, married, consulted us because of a tumor in the right breast which was hard but movable on the underlying tissue, not involving the skin. No history of injury. Small palpable nodes were felt in the axilla. Radical removal done November 8, 1918. During the period 1918 to 1923 she developed widespread metastases, one of which occurred behind the left eye. These were controlled for a period of nearly five years by irradiation. Her blood Wassermann was two plus on admission and she was given specific treatment. She was lost trace of after August, 1923, (four years, nine months from the time of admission).

The histological picture (Fig. 4) shows a typical lymphosarcoma. The cells making up the tumor are of lymphocytic type. The orderly arrangement of the lymphoid tissue is entirely lost with the absence of germinal centres, and so forth. Karyokinesis is in places very profuse, and while, in general, it is normal in type, frequent irregular figures are found in some fields. Infiltration of the tumor-cells in large masses and in small



groups is noted throughout the breast tissue and into the underlying muscle. Some of the smaller blood-vessels show an endarteritis while others are filled with tumor-cells. Some increase in fibrous tissue is noted, particularly just ahead of the advancing edges of the tumor.

CASE II—A woman, aged sixty-five years, admitted November 29, 1920. Married twenty-seven years, one stillbirth, no other pregnancies. In May, 1920, she noticed a small growth, the size of a kernel of corn, in the left breast, no history of injury. It grew larger and the breast was removed in September, 1920. The histological diagnosis of tissue removed was spindle-cell sarcoma. The blood Wassermann was negative. On examination there was a scar from the apex of the axilla to the free border of the ribs. She was given prophylactic X-ray treatments following the radical amputation and remained free from the disease until her death from cerebral hemorrhage, December 17, 1929, nine years after admission.

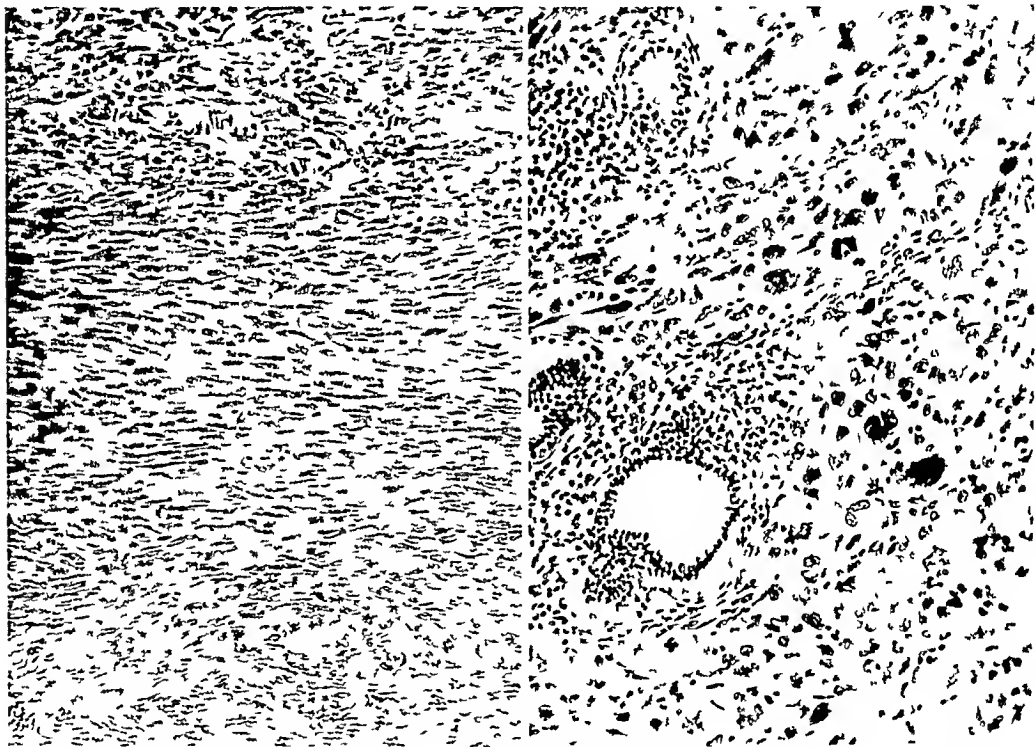


FIG. 5—Photomicrograph Case III, showing spindle cell areas

FIG. 6—Photomicrograph, Case III spindle cell sarcoma showing invasion of breast tissue

Histological examination shows a tumor made up of spindle cells. The growth does not appear to be particularly malignant. Karyokinesis, while fairly frequent in some areas, is largely confined to the centre of the tumor mass. Very few irregular mitotic figures appear. The tumor is fairly well encapsulated with a fibrous-tissue covering and apparently does not invade the underlying muscle.

CASE III—A woman, aged thirty-two years, admitted March 23, 1923. Married eleven years, three children alive and well, third pregnancy was a miscarriage at three months. Four months previous to admission she had noticed a small lump in the breast which she poulticed and to which she applied various ointments. No history of injury. Blood Wassermann was negative. At the time of examination there was a large fungating mass involving the whole left breast, with metastases in the axilla. The skin was ulcerated, red and breaking down (Fig. 1). She was subjected to high-voltage X-ray and one week later a dinner plate excision of the broken-down tumor was

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done The histological diagnosis was sarcoma She died in two months from mediastinal involvement

Histological study shows a very active tumor of the spindle-cell type There is an unusual number of dividing cells, many of which show irregular mitotic figures In some fields round and giant cells predominate The giant cells are unusually large and are both mononuclear and polynuclear types Lymphocytic infiltration is particularly prominent in these areas Other portions of the tumor show a typical spindle-cell sarcoma, with the usual spindle-shape cells of fairly uniform size Infiltration of the glandular tissue of the breast is marked throughout and the tumor nowhere shows encapsulation Blood channels lined by tumor-cells are found in all portions of the tumor In addition, some fields show acute inflammatory reaction as evidenced by the presence of many neutrophilic and eosinophilic polymorphonuclear leucocytes and plasma-cells (Figs 5 and 6)

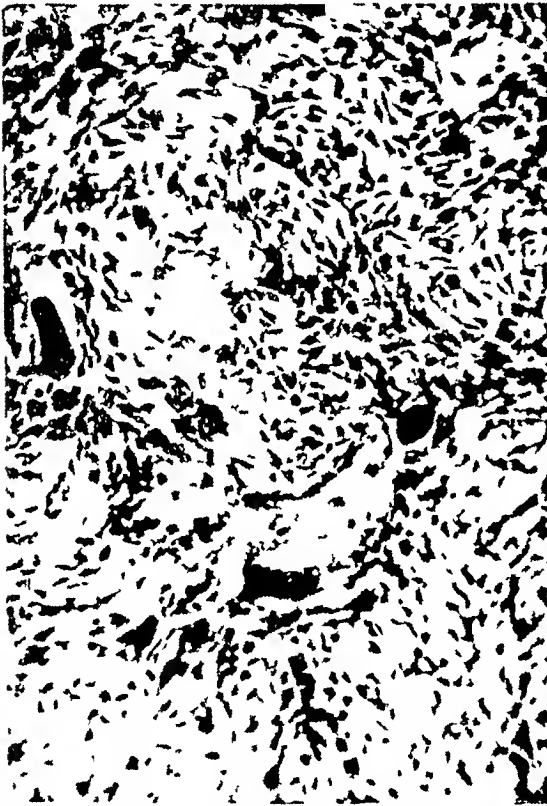


FIG 7 —Photomicrograph, Case V, showing mixed fibro osteosarcoma

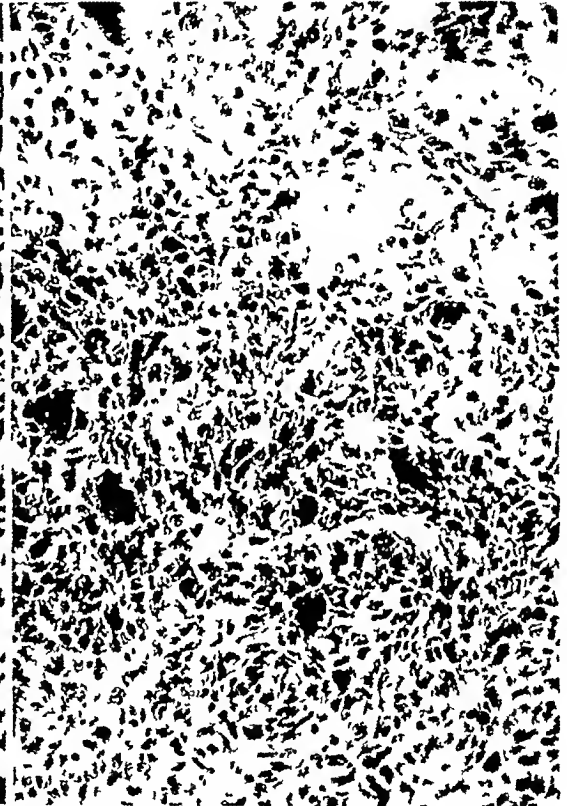


FIG 8 —Photomicrograph Case VI, showing mixed cell type sarcoma

CASE IV —A male, aged seventy-seven years, admitted August 7, 1925 Married fifty-one years Gave a history of noticing soreness and a drawing sensation in the left breast one and one-half years ago, after a short time he noticed a lump and had considerable pain No history of injury Tumor tissue had been removed from the left breast June 17, 1925, histological report of which was spindle-cell sarcoma Blood Wassermann was negative On examination there was a large symmetrical mass in the upper outer quadrant of the left breast which seemed to involve the pectoral muscles, it felt hard There was a large metastatic node in the axilla The incision, through which section had been removed, was healed fairly well He received a course of high-voltage X-ray, but the disease progressed and he died October 26, 1925, two and one-half months after admission

The histological picture is that of a typical spindle-cell sarcoma The tumor cells are of uniform size and shape Mitotic figures are frequent There is some lympho-

cystic infiltration. No encapsulation is noted and the tumor is definitely infiltrative in character. Blood channels lined with tumor-cells are noted. The pectoral muscle is involved, as are the axillary tissues.

CASE V—A woman, aged fifty-seven years, unmarried. First seen November 11, 1925, complaining of a tumor mass in the right breast. She gave a history of a small nodule in the breast at the age of sixteen which had remained stationary for a period of about forty years, and then suddenly (one year before admission) began to grow very rapidly during an attack of acute articular rheumatism. No history of injury. Blood Wassermann was negative. Examination revealed a globular swelling in the outer half of the breast, red from recent plaster application, and it seemed cystic in places. The tumor mass was removed by a local excision and a little later simple mastectomy was performed, after which there was no local recurrence but she died from intrathoracic



FIG. 9—Photomicrograph, Case VII, showing spindle cell areas

FIG. 10—Photomicrograph, Case VII, an area showing myxomatous tissue

metastasis October 19, 1926. The histological diagnosis was myxofibro-osteosarcoma. She received post-operative high-voltage X-ray treatment.

The histological picture furnished by sections of this tumor are decidedly unusual. The tumor is largely made up of cells of embryonic connective-tissue type, many of these being myxomatous in character. In addition, numerous giant cells with small multiple nuclei are liberally scattered throughout the tumor mass. Small areas of typical bone are occasionally found and these are always in close apposition to the above-mentioned giant cells. The tumor is not encapsulated and contains blood channels lined by the tumor-cells (Fig. 7).

CASE VI—A woman, aged fifty-eight years, seen January 20, 1926. Married twenty-six years, no pregnancies. One sister died of cancer of the uterus. She gave a history of first noticing a lump one month previous to admission, in the upper outer quadrant of the right breast. This tumor began to grow and there was some swelling under the arm. No history of injury. Blood Wassermann was negative. Examination revealed a tender

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nodule in the upper outer quadrant of the right breast, no palpable nodes. Radical operation was performed on the right breast and the histological diagnosis was sarcoma of the breast, axillary nodes not involved. Subsequently she received high-voltage X-ray treatment. There was no local recurrence but the patient died October 20, 1928, from intrathoracic and abdominal metastases. (Two years, nine months from the time of admission.)

Sections show a sarcoma composed of spindle, round and giant cells, areas of tumor tissue are interspersed with wide bands of dense fibrous connective tissue. In places the tumor shows definite myxomatous change. The giant cells are large and contain, as a rule, many small oval nuclei. The histological picture suggests the sarcomatous degenerations of a fibro-adenoma, as in places remnants of glandular tissue are found both in the tumor areas and in the fibrous-tissue bands. The tumor is definitely infiltrative in character and invasion of both breast tissue and of subjacent muscle are noted (Fig 8).

CASE VII—A woman, aged seventy-eight years, single, consulted us in October, 1931, because of a tremendously large tumor of the left breast. She gave a history of a tumor which was noticed eight years prior to her admission and which gradually grew to the size shown in the picture and which she was obliged to support on her left arm when walking (Fig 2). It measured sixty-three centimetres from the top of the breast to the under surfaces of the breast, thirty centimetres in diameter and weighed about sixteen pounds (Fig 3). In two places the skin looked as though it might ulcerate. Small, soft lymph-nodes were felt in the axilla. No history of injury. Blood Wassermann was negative. Chest plate was negative. In view of the discomfort operation was decided upon in spite of her advanced age. The tumor mass, together with a portion of the pectoralis major, was removed by a transverse incision, no attempt being made to do anything in a radical way. The wound healed kindly and she was subjected to high-voltage irradiation. At the present writing (February, 1932) her general health is greatly improved and there is no evidence of recurrence. Histological diagnosis was myxofibrosarcoma.

A very large breast was received in the laboratory, it weighed sixteen pounds, seven ounces, was roughly globular in shape and approximately thirty centimetres in diameter. The lower portion of the breast, below the nipple, presented a somewhat nodular appearance with stretching of the skin but no definite ulceration. On gross section of the breast, a dense white fibrous growth, in places attached to the skin surface, was disclosed. This tumor showed a glistening gelatinous surface and in places the substance is translucent. Some hæmorrhagic areas were found scattered throughout the tumor and a few cysts filled with thin stringy gelatinous fluid.

Microscopical sections showed a connective-tissue tumor made up of fibrous connective-tissue cells of embryonic type with, in many places, large areas where myxomatous changes had occurred. Some areas of necrosis are found scattered throughout the section. Marked proliferation of the smaller blood-vessels was a rather general occurrence throughout the tumor with some areas of hæmorrhagic deposit. In some fields the tumor has become more cellular with the presence of many spindle-shaped cells.

*Diagnosis*—Myxofibrosarcoma (Figs 9 and 10)

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# CANCER IN ARMY VETERANS <sup>1</sup>

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THIS study was conducted with the cooperation of the hospitals of the Veterans' Administration, Army, Navy, and U. S. Public Health service.

Included in this study were 319 cases of malignant tumors. Of this number, 317 were males and two were females. Three hundred thirteen were white patients and six were colored. Two hundred eighty-eight, or 90.3 per cent, of the 319 patients were born in the United States, and thirty-one were born in foreign countries. Two hundred fifty-nine, or 81.2 per cent of the malignant tumors were carcinoma, forty-nine, or 15.4 per cent, were sarcoma, and eleven tumors were hypernephroma, endothelioma, glioma, teratoma, or unclassified neoplasms.

Of the patients under treatment for cancer which have been the subject of this study, 68.7 per cent were veterans of the World War, 26.6 per cent were veterans of the Spanish-American War, and 4.7 per cent were veterans of "Other Wars or Expeditions."

Since about 95 per cent of hospitalized patients are veterans of the World War, little importance may be placed upon the above figures, except the per cent of veterans of the Spanish-American War hospitalized for cancer is high considering the average age of these veterans and the fact that there were approximately 234,931 alive in 1930 as compared with 4,330,598 World War veterans.

*Social Status*—Of 319 ex-service patients with malignant tumors, 78.4 per cent were or had been married, and 21.6 per cent were single.

A previous study of 1,000 hospitalized Veterans' Administration patients under treatment for various conditions showed that 62.5 per cent were married and 37.5 per cent were single. It is thus seen that the per cent of ex-service men with malignant tumors who are, or had been married, exceeds the per cent of the control group of hospitalized patients.

Sixty-seven and one-tenth per cent were from urban communities while 31 per cent were from rural sections, in 1.9 per cent of the group the place of residence was not indicated.

The probable reasons for the preponderance of cancer in urban communities are (1) The majority of the ex-service men are residents of urban communities, (2) more frequent and better opportunities for medical examinations are possible in cities and there is therefore greater likelihood of the diagnosis of cancer.

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\* Abridged from the report published in the Medical Bulletin of the Veterans' Administration of November and December 1931.

*Hereditary or Familial History*—There were fifty-two cases of malignant tumors with a positive hereditary or familial history of both. Thirty-six cases, or 69.2 per cent, gave a hereditary history of cancer, eleven, or 21.2 per cent, gave a familial history, and five, or 9.6 per cent, gave both a familial and hereditary history of cancer.

Of the fifty-two cases, forty-four were affected with carcinoma, seven were affected with sarcoma, and one was a case of endothelioma.

In those cases in which there was a hereditary history of cancer, the mother was the member of the family most frequently affected. In the group in which there was a familial history of malignancy the sister was the member of the family most frequently affected. In those cases in which there was a combined familial and hereditary history of cancer the father and brother were the members of the family most frequently affected.

While the study of this group shows that but 16.3 per cent of the total number gave a hereditary or familial history of cancer and does not definitely indicate the part played by heredity in the causation of the disease, nevertheless, consideration must be given the fact that the majority of the ex-service men have not as yet reached the cancer-age periods when malignant tumors develop as the result of such factors as trauma and irritation, biological changes of the tissue cells, chronic inflammatory changes and malignant transformation of benign neoplasms. As the ex-service men grow older and the opportunities for the development of cancer become greater it is to be expected that the hereditary and familial influences will assert themselves and contribute their share in the causation of the disease so that the number of cases with a hereditary or familial history will be markedly increased.

*Site of Tumors*—The most frequent were the skin, 19.4 per cent, the lip, 14.7 per cent, the stomach, 11 per cent, the lymph-nodes, 7.2 per cent, the rectum, 6.3 per cent, the buccal cavity, 4.4 per cent, the urinary bladder, 4.1 per cent.

*The Age Distribution of Carcinoma*—In a series of 259 patients, it was found that the largest number were within the age groups thirty-five to forty, thirty to thirty-five, forty to forty-five, and fifty to fifty-five years. In a series of forty-nine cases of sarcoma, the largest number of patients were within age groups thirty to thirty-five, thirty-five to forty, and twenty-five to thirty years. A study of the age distribution of the other types of tumors, comprising eleven cases, showed that the largest number, six, were within the age group thirty-five to forty.

From the above it would appear that the age group thirty-five to forty is the most critical period from the standpoint of the onset and incidence of malignant disease. In susceptible individuals all factors which tend to result in malignant tumors, such as continual irritation, chronic inflammation, benign growths, etc., should receive appropriate treatment prior to or during this period with a view to the prevention of cancer.

Ewing maintains that senile atrophy of tissues and organs, replacement fibrosis, and arteriosclerosis create local conditions which favor the develop-

ment of some cancers. He states that the main factor which accounts for the high incidence of cancer in the aged is the lapse of time which permits the natural termination in cancer of processes which have their inception in adult life, in youth, in infancy, or even *in utero*. That the majority of tumors of old age may be thus explained cannot be asserted without much more evidence than is now available, but appears highly probable.

*Age at Time of Onset of Cancer* —In 1851, Lebert made a study of the ages at the time of the onset of various types of malignant tumors in a series of cases and found that the mean age for the whole group was fifty-one years. In 1930, Pack and LeFevre found that the mean age of the onset of malignant tumors in a group of cases was 53.9 years.

Of the group of 319 ex-service patients, the histories of 303 indicated that the mean age at the time of the onset of cancer varied from twenty-nine years in the case of teratoma of the genito-urinary tract to a mean age of fifty-two years in the case of sarcoma of the digestive tract. The mean age of the whole group at the time of onset of cancer was forty-three years. It is further noted that there is a difference of ten years between Pack's and LeFevre's findings and the findings in this study. The explanation is that we are dealing with a select group of ex-service men of an average age of approximately forty years.

*Weight at Time of Inception of Cancer* —Inasmuch as little information is available upon this subject it was decided to include in this investigation a study of the weight of the patients at the time of the onset of cancer. The weight in each case was correlated with the age and the height of the patient and a determination was made whether or not it was within normal range ( $+5$  per cent to  $-5$  per cent). If above or below the normal range an estimate was made of the per cent of increase or decrease of weight as compared with normal. In 226 patients with malignant tumors, 39.8 per cent of the number were below the standard weight at the time of onset of cancer, 26.1 per cent were above the standard weight, and 34.1 per cent were within the normal standard range of weight. Of the fifty-nine cases above the standard weight at the time of the onset of cancer, the largest group, twenty-one cases, showed a deviation of 6 to 10 per cent, and the next largest group, nineteen cases, showed an increase over normal weight of 11 to 20 per cent. Of the ninety cases below standard weight at the time of the onset of cancer, the largest group, consisting of forty-nine cases, showed a decrease from normal weight of 11 to 20 per cent, and the next largest group, of thirty cases, showed a decrease from the normal weight of 6 to 10 per cent.

From the above information it would appear that there is no correlation of weight with the inception of cancer. While an appreciable number of patients of the group were overweight in the early stages of the disease, the majority were either underweight or within the normal range of weight for height and age.

*Occupation* —That certain occupations predispose to the inception of cancer is an established fact. Some of the occupations which are etiological fac-

tors of cancer are Chimney sweeping, gardening, work in coal-tar and pitch industries, and X-ray work W Roger Williams maintains that farm laborers, gardeners, sailors and those who follow out-door occupations are unduly prone to cancer of the lower lip

In a study of the occupation of 238 members of the group, it was found that 125, or 52.9 per cent, were engaged in technical or industrial pursuits, fifty-eight, or 24.3 per cent, were engaged in agriculture or allied pursuits, forty-five, or 18.8 per cent, were engaged in commercial pursuits, and ten, or 4 per cent, were in various professions

In order to ascertain whether or not there was a relationship of occupation to the causation of cancer, a study was made of 128 members of the group with malignant tumors of various organs and sites, forty-eight of which were cases of malignant neoplasms of the skin or mucous membrane Of forty-eight cases of cancer of the skin or mucous membrane, in twenty-five instances it was present in farmers and ranchers It is realized, of course, that the actinic rays and the outdoor life of the farmer or rancher may act as irritants and be factors in the causation of cancer of the skin There was no other indication of a relationship existing between any occupation and cancer of a particular organ or site

*Chronic Irritation or Chronic Inflammation as Forerunner of Malignant Neoplasms*—Of 319 cases of cancer, 128, or 40 per cent of the group, gave a well-defined history of a previous irritation or chronic inflammatory process This is in accord with the views now held by many observers that the development of malignancy is dependent upon (1) An extrinsic factor of irritation or inflammation, (2) an inherited constitutional cancer susceptibility, (3) an inherited organ or tissue predisposition The opinion also prevails that the irritation or inflammation may in some instances take the place of the local organ or tissue predisposition

The relationship of trauma or inflammation to the development of cancer is not thoroughly understood but the following hypothesis has been formulated to explain the mechanism of the transition of normal tissue cells to malignant cells

Trauma of living cells or a chronic inflammatory process is usually followed by an attempt at repair, and leads to a temporary change of "potential" growth ability to "kinetic" growth ability, i e, it leads to a temporary elimination of "growth restraint," a property possessed by matured tissues or organs What follows, then, is a multiplication of the cells in the traumatized or inflamed area at an unnatural and accelerated rate, due to the absence of the property of "growth restraint" and the loss by the cells of the normal property of physiological repair

One hundred, or 78.1 per cent, of the total of 128 patients with a history of chronic irritation or inflammation, had carcinomas, twenty-six, or 20.3 per cent, had sarcomas, one was a case of endothelioma, and one was a case of teratoma The most frequent sites of malignant tumors in which there was a previous history of chronic irritation or chronic inflammation



were The skin or mucous membrane, the digestive tract, the genito-urinary system, the buccal cavity, the bones and the lymphatic system

*Use of Tobacco*—Of the total number of 319 cases, it was found that in seventy-six instances the malignant tumors might be attributable to smoking The principal sites of the cancers were as follows Forty-five cases were on the lip, nine were in the mouth, seven were on the tongue, and five were cases of carcinoma of the larynx The largest number, twenty-six, or 34.2 per cent, were cigarette smokers, thirteen, or 17.1 per cent, were pipe smokers, and eight, or 10.5 per cent, were cigar smokers

Twelve, or 15.8 per cent, of the group did not use tobacco, seven of these twelve patients had carcinoma of the lip

*Pre-Cancerous State*—In reviewing the clinical records of the group of 319 cases, it was found that eighty-eight, or 27.6 per cent, gave a history of having had some forerunner or pre-cancerous condition prior to the actual development of cancer The pre-cancerous condition was of a varied type, such as a chronic ulceration or fissure formation of the skin, pigmented mole, keratosis, gastric ulceration, papilloma, adenoma, etc

While but 27.6 per cent of the patients gave clinical evidence of the presence of a pre-cancerous condition, the probabilities are that the number would have been greater if special means had been used to detect this condition, it is frequently symptomless and is difficult of diagnosis, particularly if it is situated in deep-seated organs or tissues

Malignant disease is not a spontaneous, fully developed condition, but is the result of evolutionary changes of tissue cells through various stages, which, at first, are benign and subsequently assume malignant qualities The changes through which tissue cells pass may be inflammatory, hyperplastic or neoplastic—any of these may terminate in cancer

*Characteristics of Malignant Neoplasms*—The characteristics of malignant neoplasms are dependent upon the location of the growth and upon the type of tumor If the tumor is preponderantly cellular it is usually of a soft consistency On the other hand, if much fibrous connective tissue is present in the growth, induration is the rule

In reviewing the histories of 297 patients with malignant tumors, it was found that the most common characteristics were a combination of induration and ulceration, the next most frequent characteristic was induration, ulceration was next in frequency, and a combined tumor formation and induration appeared to be the next most common characteristic

*Early Symptoms of Malignant Tumors*—In view of the fact the favorable outcome of cancer is dependent upon the institution of early treatment, it is highly desirable that one know the initial symptoms and signs of the disease so that an early diagnosis may be made At times, this is a difficult matter, inasmuch as tumors in certain locations are symptomless or possess no definite or characteristic signs by means of which a diagnosis may be made

Of 259 Veterans' Administration patients affected with carcinoma, the most frequent symptoms and signs which first directed attention to the malignant neoplasm were ulceration, tumor formation, pain, bleeding, and loss of weight

The symptoms and signs most frequently found in the early stages of forty-nine cases of sarcoma were tumor formation, pain, loss of weight, and ulceration. The group of tumors other than carcinoma and sarcoma, eleven in number, manifested the following symptoms and signs during the early stages of the disease: tumor formation and pain.

In the consideration of the total number of 319 cases, the most frequent early symptoms and signs of malignant disease noted were tumor formation, pain, ulceration, bleeding, and loss of weight.

*Symptoms of Cancer During Hospitalization*—While cancer is at first localized and the symptoms and signs present are referable to the site of the tumor, there is a gradual development of constitutional symptoms as the disease progresses. The principal symptoms and signs noted among the 319 patients under hospitalization at the time of this study, in the order of frequency, were pain, tumor, loss of weight, ulceration, loss of appetite, cachexia, anæmia, bleeding, discharge, insomnia, and nervousness.

*Rate of Growth*—A study of the rate of growth of neoplasms in the group of ex-service patients under hospitalization for malignant disease shows that in 62.7 per cent the rate of growth of the tumor was slow, in 36.1 per cent of the cases there was a rapid growth, and in 1.2 per cent of the cases the rate of growth was unknown. It was further noted that the per cent of sarcomas giving a history of rapid growth was greater than the per cent of carcinomas.

*Incidence of Pain at Time of Onset of Malignant Tumor*—In a review of the clinical data it was found that 304 of the group gave a history of the presence or absence of pain at the time of the origin of malignant disease, while in fifteen instances this information was not recorded.

Of the 304 cases, 140, or 46.0 per cent, gave a definite history of pain at the time of the onset of the growth, eighty-nine, or 29.3 per cent, developed pain after the onset of the growth, while seventy-five, or 24.7 per cent, had no pain during the course of the neoplastic disease. Of seventy-two cases of carcinoma of the digestive tract, fifty-three, or 73.6 per cent, gave a positive history of pain at the time of the onset of the growth. Of 104 cases of carcinoma of the skin or mucous membrane, twenty-eight, or 26.9 per cent, gave a positive history of pain at the time of the onset of the malignant growth, forty-eight, or 46.2 per cent, gave a negative history of pain, while twenty-eight, or 26.9 per cent, developed pain after the onset of the tumor. It was further noted that in seventeen cases of sarcoma of the lymphatic system, six, or 35.3 per cent, gave a positive history of pain at the time of the onset of the malignant tumor, six, or 35.3 per cent, gave a negative history of pain, and five, or 29.4 per cent, developed pain after the onset of the malignant tumor.

*Length of Time Between Onset of Cancer and Appearance of Pain—*

It was stated that eighty-nine, or 29.3 per cent, of a total of 304 patients with malignant tumors developed pain after the onset of the neoplasm. Further study was made of the clinical records of this group to ascertain the known length of time extending from the date of onset of cancer to the date of the appearance of pain. This information was obtainable in seventy-five cases and it was found that the length of time varied, depending upon the type of malignant tumor as well as upon the organ or site of the disease.

For instance, in twelve cases of carcinoma of the digestive tract the shortest length of time from the onset of the tumor to the appearance of pain was two weeks, the longest period was 144 months, and the average period was 22.4 months. For sixty cases of carcinoma of various kinds the shortest length of time before pain appeared was two weeks, the longest period was 144 months, and the average period was 20.4 months. For thirteen cases of sarcoma of all kinds the shortest length of time before pain appeared was one month, and the longest period was seventy-two months, the average period was sixteen months.

Taking the whole group of seventy-five cases of cancer into consideration, the shortest period from the time of the onset of the disease to the appearance of pain was two weeks, the longest period was 144 months, and the average period was 20.7 months.

The above data would indicate that frequently pain does not appear in the early stages of cancer. The patient may therefore not be cognizant of the nature of the condition, inasmuch as the other symptoms present are not suggestive of a neoplasm nor are they serious enough for the patient to seek medical advice.

*Delayed Diagnosis of Cancer*—It is a well-known fact that the principal cause of the hopelessness of the treatment of cancer is that it is instituted too late, the reason being that there is a delay in making a definite diagnosis. Frequently, when the patient is first seen by the physician, the condition is in a pre-cancerous state, *i e.*, it is either a chronic inflammatory process or perhaps a benign neoplasm, which may be responsible for the insidious and vague symptoms that are not considered alarming by the patient. Frequently there is no pain or discomfort associated with these pre-cancerous conditions.

If medical or surgical advice is sought the physician may overlook the potential seriousness of the condition and administer symptomatic treatment only. Later, when the condition has become manifestly malignant and subjective and objective symptoms arise, which again force the patient to the physician, the seriousness of the disease is noted and radical remedial measures are instituted. Unfortunately, by this time the cancer has reached such an advanced stage that little benefit can be derived from the treatment administered.

In order to study this phase of cancer the clinical data of a group of patients were reviewed and it was found that of 315 cases, 201 were treated

for various conditions before a diagnosis of malignant tumor was made, in sixty-two instances there was no treatment prior to the diagnosis of malignant tumor, in fifty-two instances there was no record of any previous treatment nor could any information on this point be obtained

It is of interest that of the 201 cases who were treated for some non-neoplastic disease before a definite diagnosis of cancer was made, 105, or 52.2 per cent, were treated for periods less than one year, twenty-five, or 12.4 per cent, from one to two years, altogether 85 per cent of the group were treated for various periods up to six years. In some instances, patients were treated as long as twenty years before a diagnosis of cancer was definitely made

*Metastases*—An attempt was made to ascertain the number of cases showing metastatic growths in the group of 319 patients under hospitalization for cancer. The largest number of these patients were in the younger age groups. One hundred and twelve, or 35.1 per cent, showed the presence of metastases, and 207, or 64.9 per cent, gave no evidence of metastatic involvement

The most common tumors and their sites showing metastases, in the order of frequency, were carcinoma of the digestive tract, carcinoma of the skin or mucous membrane, sarcoma of the lymphatic system, carcinoma of the buccal cavity, and carcinoma of the genito-urinary tract

*Coexisting Diseases*—The relationship of certain diseases to cancer has been frequently discussed but no definite conclusion has been reached except that it has been held that active tuberculosis seldom coexists with malignant tumors. Attempts have been made by many observers to show a relationship of syphilis, rheumatism and diabetes mellitus to cancer, but the findings have not been convincing

*Syphilis*—The consensus of opinion appears to be that the relationship of syphilis to cancer is very remote. Among the 319 patients with cancer, syphilis was a coexisting disease in 2.1 per cent of the cases

*Arthritis or Rheumatism*—A good deal of information is found in the literature on the relationship of arthritis and rheumatism to cancer, but the conclusions reached are not based upon reliable evidence. Of the total number of 319 cases of cancer, 6.9 per cent had coexisting arthritides or rheumatic affections

*Diabetes Mellitus*—Some observers are of the opinion that there is a well-defined correlation of diabetes mellitus with cancer. The over-indulgence of food so commonly encountered in diabetes mellitus may result in abnormal metabolic changes which later may become a predisposing factor of cancer. Of the group of 319 patients, 1.9 per cent had a coexisting diabetic condition

*Tuberculosis*—Rokitansky, Pearl, and others have shown that there is an antagonism between tuberculosis and cancer. On the other hand, Carlson and Bell are of the opinion that the findings of Pearl were arrived at by a statistical method to which they objected. Fortune holds that the subject with

tuberculosis is less apt to acquire cancer only because he succumbs to tuberculosis before he reaches the cancer age

In a study of the necropsy material of the Veterans' Administration, the writer found that cancer was more prevalent among non-tuberculous beneficiaries than in those with tuberculosis, and, furthermore, that tuberculosis was more frequent among non-cancerous cases than in those with malignant neoplasms. However, there is nothing in the data to show that there is a biological antagonism of one disease against the other

Of the 319 cases of cancer, four had a coexisting active pulmonary tuberculosis, one had inactive pulmonary tuberculosis, five were cases of arrested pulmonary tuberculosis, and one was a case of tuberculosis of the dorsal vertebræ

*Known Duration of Malignant Neoplasms*—In a study of the duration of malignant neoplasms in New York State it was found that among 814 males, 39.4 per cent had a known duration of less than one year, 57.2 per cent had a known duration of from one to four years, and in 3.4 per cent of the cases the duration was five years or over. The large majority of cancer deaths followed a previous known duration of from six to twenty-four months

The known duration of cancer as estimated in this study extends from the date of onset of the disease to the date of death. It is noted that in the case of sixty-six carcinomas 37.9 per cent showed a known duration of less than one year, 24.3 per cent from two to three years, and 19.7 per cent from one to two years. Of twenty sarcomas 40 per cent showed a known duration of less than one year and 40 per cent from one to two years. Taking the whole group of eighty-nine cases into consideration, 38.2 per cent had a known duration of less than one year, 25.8 per cent from one to two years, and 18 per cent from two to three years. Among sixty-six cases of carcinoma, the minimum known duration was two months, the maximum duration was 156 months, and the mean known duration was 28.3 months. Of twenty cases of sarcoma, the minimum known duration was two months, the maximum duration was sixty months, and the mean known duration was 18.2 months. Taking the group of eighty-nine cases into consideration the minimum known duration of all forms of malignancy was two months, the maximum duration was 156 months, and the mean known duration was 25.6 months

*Living Cases*—The known duration of malignant neoplasms among a group of 203 living veterans whose clinical records contained this particular information extends from the date of onset of the condition to the date of this study (September, 1930). It was noted that in the case of 172 carcinomas, 23.3 per cent had a known duration of less than one year, 23.3 per cent from one to two years, and 16.3 per cent from two to three years. Of twenty-six sarcomas 15.4 per cent showed a known duration of from ten to eleven years, 15.4 per cent from five to six years, 11.6 per cent from twelve to thirteen years, 11.6 per cent for periods less than one year, 11.6

per cent from one to two years, and 11.6 per cent from two to three years. Taking the whole group of living veterans with cancer into consideration, 203 in number, 22.7 per cent, showed a known duration of less than one year, 21.2 per cent from one to two years, and 15.8 per cent from two to three years. Among 172 carcinomas the minimum known duration was one month, the maximum known duration was 216 months, and the mean known duration was 42.3 months. Of twenty-six sarcomas the minimum known duration was six months, the maximum known duration was 156 months, and the mean known duration was 68.8 months. Considering the whole group of 203 living cases the minimum known duration was one month, the maximum known duration was 216 months, and the mean known duration was 45.5 months.

It is noted that the mean known duration of the living sarcoma cases was greater than the mean known duration of the cases of carcinoma, while among the deceased cases of malignant neoplasms the mean known duration of cases of sarcoma was less than the mean known duration of cases of carcinoma. The mean known duration of all of the deceased cases of cancer was 25.6 months while in the living cases it is 45.5 months up to the date of this study.

*Classification of Patients with Cancer According to Activity*—The outstanding symptoms of cancer are weakness and loss of strength with the result that the patient is unable to carry on his accustomed work. There is therefore an impairment of his economic efficiency and a reduced earning capacity. The classification of the activity of the patients with cancer used in this study is similar to that used by the American Heart Association in the grouping of patients affected with heart disease. Altogether, 318 of the patients were classified.

It is noted that 25.8 per cent were able to carry on ordinary physical activity, in 13.8 per cent of the group the activity was slightly limited, in 22.3 per cent activity was greatly limited, and 38.1 per cent of the patients were unable to carry on any physical activity *i.e.*, they were bed patients.

Of the patients who were able to carry on ordinary physical activity, the largest number were among those affected with carcinoma of the skin or mucous membrane. Of the patients whose activity was slightly limited, the largest number were among cases of carcinoma of the skin or mucous membrane. Of the patients whose activity was greatly limited the largest number were among those with carcinoma of the digestive tract. Of the patients who were unable to carry on any physical activity and were confined to bed, the largest number were among those with carcinoma of the digestive tract.

The activity of patients with cancer is dependent to a considerable extent upon the site as well as upon the stage of the disease. Frequently tumors give rise to constitutional symptomatology during the incipient stages so that activity is greatly limited from the first. This is commonly found in tumors of the digestive tract and of the lymphatic system. As a general

rule, however, constitutional symptoms of cancer develop in the later stages, and when this occurs the activity of the patient is usually very much curtailed

*Treatment*—In the treatment of the group of patients under hospitalization for malignant neoplasms the following regimens were used (1) Symptomatic therapy, (2) X-ray, (3) radium, (4) surgery, (5) cautery, (6) Coley's toxin. In addition, a number of combinations of these regimens were utilized—the kind of treatment depending upon the site and type of malignant tumor as well as upon the stage of the disease

In the hospitalization of a group of 315 patients with malignant tumors the most frequent forms of treatment used were (1) Surgery and X-ray, (2) surgery, (3) symptomatic therapy, (4) X-ray, (5) surgery, X-ray and radium, (6) radium, (7) surgery and radium

*Result of Treatment*—The result of treatment of malignant tumors depends upon a number of factors, such as The type of treatment, the type of cancer and the organ affected, the stage of the disease at the time treatment is first instituted, and in addition the outcome of the case is dependent upon whether or not there is glandular involvement and also if metastases are present at the time treatment is administered. It is a well-known fact that malignant neoplasms of certain organs or sites are best treated by certain particular regimens and the results with these regimens are better than if other forms of treatment are used

Of 315 beneficiaries undergoing hospitalization for cancer, 42.8 per cent were considered improved upon the termination of the hospitalization, 20 per cent were unimproved, 5.1 per cent were worse, and 32.1 per cent died during the period of hospitalization. The condition of some of the patients was recorded as "cured," but it was thought best to consider them as "improved," inasmuch as sufficient time had not elapsed to justify the former classification

In explanation of the percentage of deaths (32.1) it may be stated that a large number of the patients were admitted to the hospitals in an advanced stage of the disease, too late to receive benefit from the treatment administered

A study of the records to ascertain the results with various forms of treatment revealed the following information. Of the twenty-two patients receiving radium treatment, 86.4 per cent were alive and 13.6 per cent had died

Of twenty-eight patients receiving X-ray, radium and surgical treatment, 85.7 per cent were alive and 14.3 per cent died. Of fifteen patients receiving radium and surgical treatment, 73.3 per cent were alive and 26.7 per cent died. Forty patients received X-ray treatment, and of this number 70 per cent were alive and 30 per cent died. Fifty-five patients were treated by means of X-ray and surgery, of which number 69.1 per cent were alive and 30.9 per cent died. Twelve patients were treated with X-ray and radium and of this number 66.6 per cent were alive and 33.4 per cent died. Eleven patients were treated by X-ray, surgery and cautery, and of this

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number 63.6 per cent were alive and 36.4 per cent died. Forty-seven patients were treated by surgical means, of which number 61.7 per cent were alive and 38.3 per cent died. Forty-six patients were treated symptomatically, and of this number 41.3 per cent were alive and 58.7 per cent died.

A study was made to ascertain the best methods used in the treatment of malignancy of various organs and tissues as judged by the most favorable results, and the following information was obtained:

*Carcinoma of the Skin or Mucous Membrane*—There were 104 patients treated. The best results were obtained by the use of the following procedures in the order named: (a) surgery, (b) surgery and cautery, (c) radium, and (d) X-ray and surgery.

*Carcinoma of the Buccal Cavity*—Twenty-three patients were treated for malignancy of the buccal cavity. The best results were obtained by the use of the following procedures in the order named: (a) radium, (b) cautery, (c) radium and X-ray, and (d) X-ray, radium and surgery.

*Carcinoma of the Digestive Tract*—Seventy-seven patients were under treatment for carcinoma of various portions of the digestive tract. The best results were obtained by the use of (a) surgery and X-ray, and (b) X-ray, in the order named.

*Carcinoma of the Genito-urinary Tract*—Twenty-one patients were treated for cancer of the genito-urinary tract. The best results were obtained by the use of surgery and X-ray.

*Sarcoma of Bone*—Eight patients were treated for this type of malignant neoplasm. The best results were obtained by a combination of X-ray, radium and surgery.

*Sarcoma of the Lymphatic System*—Seventeen patients were treated for this form of malignant neoplasm. The best results were obtained by the use of (a) X-ray and radium, and (b) X-ray, surgery and cautery, in the order named.

### CORRELATION OF TYPE OF TREATMENT WITH KNOWN DURATION OF MALIGNANT NEOPLASMS

The type of treatment as well as the known duration of life following the same were studied for the purpose of ascertaining whether or not there was a correlation between these two factors. The study yielded the following data:

*Symptomatic Treatment*—Of a group of nineteen living patients treated symptomatically for malignant neoplasms the average known duration of the disease from the date of onset to the date of this study (September, 1930) was 44.8 months.

Of a group of twenty-seven patients with malignant neoplasms who died and who had been treated symptomatically the average known duration of life following such treatment was 20.7 months.

*Radium Therapy*—Of a group of nineteen living patients who had re-



ceived treatment with radium the average known duration of life up to the date of this study (September, 1930) was 42 7 months

Three patients with cancer who died and who had been treated by means of radium had an average known duration of life of 12 7 months

*X-ray Therapy*—Of a group of twenty-eight living patients with cancer who had received X-ray treatment the average known duration of life up to the date of this study (September, 1930) was fifty-two months

Twelve patients with cancer who died and who had been treated by means of X-ray had an average known duration of life of 13 5 months

*X-ray and Radium Therapy*—Of a group of eight living patients with cancer who had received combined X-ray and radium treatment the average known duration of life up to the date of this study (September, 1930) was 35 9 months

Four patients with cancer who died and who had been treated by means of X-ray and radium had an average known duration of life of fifty-three months

*Surgical Treatment*—This group includes forty-seven patients who underwent surgical operations, eleven patients treated by means of cautery, seven patients who underwent both surgical operations and treatment with cautery, and one patient, who, in addition to surgical treatment, received toxin therapy

Of a group of forty-six living patients with cancer who had received surgical treatment the average known duration of life up to the date of this study (September, 1930) was 35 3 months The shortest average known duration, that of 5 5 months, was noted in the case of carcinoma of the tongue, the longest average known duration, that of 144 months, was in a case of carcinoma of the larynx

Of the patients who received surgical treatment the average time between the date of onset and date of operation was 22 7 months The shortest average interval that of 2 5 months, was in the case of carcinoma of the rectum, the longest average period of time, that of 144 months, was in a case of carcinoma of the larynx

Twenty patients with cancer who died and who had undergone surgical treatment had an average known duration of life of 25 2 months The longest average known duration that of 41 6 months, was seen in carcinoma of the stomach, the shortest average known duration of time, that of two months was seen in carcinoma of the rectum The average period of time from the date of onset to the date of surgical operation was 6 1 months The shortest average known time that of one month, was noted in carcinoma of the skin, the longest average known time, that of ten months, was noted in carcinoma of the larynx

*Surgery and Irradiation*—Of a group of ninety-three living patients with cancer who had received both surgical treatment and irradiation therapy the average known duration of life up to the date of the study (September, 1930) was 47 1 months The longest average known duration, that of 100

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months, was noted in the case of malignant tumors of bone, the shortest known duration, that of nine months, was noted in the case of carcinoma of the tongue

The average period of time between the onset of the disease and the date of the surgical treatment was 41.5 months. The shortest average time, that of 18.4 months, was in the case of carcinoma of the stomach, the longest average interval, that of seventy-seven months, was in the case of carcinoma of bone.

Thirty-four patients with malignant tumors who died and who had been treated by means of surgery and irradiation had an average known duration of life of 31.1 months. The longest average known duration, that of 54.7 months, was among patients with carcinoma of the skin.

The average period between the onset of the disease and the date of surgical intervention was 9.8 months. The shortest average period of time, that of two months, was recorded in the case of carcinoma of the buccal cavity, the longest average period, that of 23.4 months, was noted in the case of malignancy of the lymph-nodes.

In comparing the average known period of time between the onset of cancer and the date of surgical intervention in those patients who received surgical treatment alone with those who received irradiation and surgical treatment, it is found that on the whole the interval of the patients who underwent surgical treatment was shorter than that of the patients who received both irradiation as well as surgical treatment.

It may be assumed that in the majority of instances irradiation was used first and was later followed by surgery. The known duration of life following the combined surgical and irradiation regimens was longer than that following surgery alone.

*Relative Potency of Therapeutic Regimens*—The results with each type of treatment as judged by the largest per cent of the patients alive upon the termination of the hospital episode were compared, and the following treatment regimens in the order named, were found to be the most effective: (1) radium, (2) surgery and irradiation, (3) X-ray, (4) surgery, (5) X-ray and radium, (6) symptomatic treatment.

*Known Duration of Cancer Correlated with Type of Treatment*—Of a group of 213 patients under treatment for cancer and alive at the time of this study the average known duration of the disease was 44.1 months. The longest average known duration, that of fifty-two months, was noted in the case of twenty-eight patients treated with X-ray. The shortest average known duration, that of 35.3 months, was noted in forty-six cases of malignancy treated by means of surgery. Nineteen patients who were treated symptomatically showed an average known duration of 44.8 months.

One hundred of the group of patients under treatment for cancer died during the hospital episode. The average known duration of the disease in this group was 25.9 months. The longest average known duration, that of fifty-three months, was noted in four patients treated with X-ray and radium.

The shortest average known duration, that of 12.7 months, was noted in three patients treated with radium. Twenty-seven patients who died during the hospital episode were treated symptomatically and the average known duration of cancer was 20.7 months.

*The Deaths*—Of the 319 cases hospitalized for malignant neoplasms, 101 died during the hospital stay. In this connection it must be understood that beneficiaries are admitted to Veterans' Administration and other Government hospitals upon the presentation of evidence of discharge from the military service. A number of the patients who died during hospitalization were in the terminal stages of cancer upon admission, too far advanced with the disease to be aided by any treatment.

The most frequent sites of the malignant neoplasms of patients dying were the digestive tract, the skin or mucous membrane, the buccal cavity, the lymphatic system and the genito-urinary tract.

The most frequent causes of death were carcinoma of the digestive tract, carcinoma of the buccal cavity, carcinoma of the skin or mucous membrane, sarcoma of the lymphatic system, carcinoma of the genito-urinary tract and surgical shock.

In the group of 101 cases under treatment for malignant neoplasms who died while being hospitalized, seventy-nine, or 78.2 per cent, died from the malignant tumor, and 22 or 21.8, died from other causes. The most frequent causes of death other than malignant tumors were surgical shock, hæmorrhage, cedema, and intestinal obstruction.

In the discussion of the age at death of the 101 cases of malignant tumor, it must be understood that we are dealing with a select group of males of an average age of forty years. It will be noted that the ages at death of these patients are below the ages at death from cancer in the general population. The age at death from malignant tumor is dependent upon a number of factors, such as the age at the time of onset, the duration, as well as the type and site of the malignant tumor, and the treatment administered.

In this connection it is desired to point out that certain tumors of young subjects are rapidly growing and highly malignant. The clinical history of such cases is that of a rapid course and high mortality. Broders has shown that the active tissues of youth invite the growth of malignant tumors instead of resisting their spread and the host has little chance for longevity, regardless of the type of treatment administered.

Of the patients who died the largest number, twenty-two, or 21.8 per cent, were within the age groups forty to forty-five and thirty-five to forty, the next largest number, fourteen, or 13.8 per cent, were within the age group thirty to thirty-five. Of seventy-six cases of carcinoma the minimum age was thirty-one, the maximum age was eighty-two, and the mean age was 47.6 years. Of twenty-one cases of sarcoma the minimum age was thirty-one, the maximum age was sixty-eight, and the mean age was 42.5 years. Of the whole group of 101 cases the minimum age at death was thirty-one, the maximum age was eighty-two, and the mean age at death was 46.2 years.

# GASTRECTOMY

AN EXPERIMENTAL STUDY\*

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STUDY of the effect of total removal of the different organs of the body has been of value in several respects. It has been determined that some organs are vital, that is, necessary for life, and that others are not. In some instances, knowledge concerning the function of an organ has been revealed by a study of the effect of its removal, in other instances, the method whereby the body compensates for the loss of an organ has been revealed by removal of the organ. Technical methods for the removal of organs have been worked out experimentally. Many of the studies on the effect of removal have been of value to clinical medicine. We shall report here the results of removal of one of the important organs, the stomach.

Hartman<sup>18</sup> noted a condition in which most of the characteristics of pernicious anæmia were associated in a case in which W J Mayo had removed the stomach a considerable time previously. This observation emphasized in another way the possible causal relationship between achylia gastrica and pernicious anæmia. At Hartman's suggestion, we undertook a study of the effect of the removal of the stomach of dogs. During several years in which this problem has been under investigation, other cases of pernicious anæmia in which the stomach had been removed have been reported,<sup>19</sup> the stomach has been removed from human beings more frequently,<sup>10, 26</sup> a relationship between gastric function and pernicious anæmia has been noted,<sup>6</sup> and newer and apparently more fruitful experimental work on exclusion and removal of the stomach has been described.<sup>9, 15</sup>

## REVIEW OF THE LITERATURE

Czeiny and Kaisei<sup>8</sup> were apparently the first to attempt total removal of the stomach of dogs. A series of operations was performed in which an attempt was made to remove the stomach and to anastomose the duodenum to the œsophagus. One animal survived the operation five years, but at necropsy a small gastric pouch was found. Evidently a minute remnant of stomach was left attached to the œsophagus, for at the time of operation the surgeons were confident that extirpation was complete. Monari<sup>17</sup> attempted the operation on a dog. The animal survived the operation, but at necropsy a piece of

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cardia was found. In like manner a fragment of cardia was found to have been left at operation by Carvallo and Pachon<sup>4</sup>. They concluded that complete extirpation of the stomach of a dog through the abdominal route is not possible, and that the abdominal portion of the œsophagus after resection of the stomach is too short to permit anastomosis. They also removed the stomach of cats, and found that the operation was relatively easy because of a peculiar anatomical arrangement of fibrous bands extending from the diaphragm onto the œsophagus, and the fact that in the cat the abdominal portion of the œsophagus is more extensive than in the dog. In the latter respect the operation on the cat was more comparable to conditions that obtain in man. It was found that healing of the suture line was sufficient at the end of the third day to permit the feeding of solid food. As the most significant condition found at necropsy was pulmonary congestion, they assumed the section of the vagi to be of considerable importance. The only cat that survived operation for a long period lived for seven months. The cat ate normally and gained weight steadily for four months, then refused food, and was fed with a stomach tube. Death occurred soon after forced feeding was discontinued. Carvallo and Pachon<sup>7</sup> concluded that the stomach is not indispensable for the maintenance of life, but that it is important in reflexly initiating a peripheral sensation of hunger.

Grohe<sup>12</sup> attempted total removal of the stomach from the dog, but the only animal to survive had a remnant of cardia.

Cattel, Myer, and Levene<sup>3</sup> performed gastrectomy on two dogs in the course of a study of nitrogen metabolism. Fourteen weeks after the operation at which time the animals were killed, a small portion of pylorus was found in one of the animals.

Unger reported experiments on dogs by Bettmann<sup>1</sup> in which the stomach was removed through the transthoracic route with the aid of Meltzer-Auer insufflation anæsthesia. The duodenum was anastomosed to the œsophageal stump.

Verson<sup>25</sup> described a similar method for removing the stomach of dogs by the transthoracic route, and a year later he reported the results of his experiments. The animal that lived longest lived for nine days.

The most recent and significant work on the problem has been done by Ivy and his associates<sup>15</sup>. They removed the stomach from fourteen dogs, and observed the animals for periods of six months to seven years. However, the stomach was removed completely from only three of the dogs. In the other operations a closed pouch was made of the stomach, thus removing the viscus physiologically. The operations were done in one stage with a relatively low mortality. The duodenum was anastomosed to the œsophagus by the end-to-side method. These investigators found that gastrectomized dogs if properly fed were maintained surprisingly well. Spontaneous anæmia developed in three of the fourteen dogs with absolute achylia gastrica on a diet which was adequate for normal dogs. Pregnancy uniformly induced anæmia (three times in one dog, one time each in two dogs). Ivy and his

associates<sup>15</sup> believe the achlorhydria was a predisposing factor for the development of anæmia in that it reduced the factor of safety of digestion

Clinically, the operation of total gastrectomy is now generally accepted as definitely indicated in certain conditions. Apparently it was first attempted on a human being by Conner<sup>7</sup> when gastric surgery was in an early stage of development, and even the operation of partial gastrectomy was considered unjustifiable by many surgeons. Since Conner's patient died in the course of the operation, it is not to be wondered at that many years intervened before the operation was again attempted. Schlatter<sup>22</sup> reported the second case which was successful, the patient lived fourteen months after complete removal of the stomach for carcinoma. Exhaustive reviews of all the cases of total gastrectomy in human beings have been made by Uhlhorn,<sup>24</sup> and by Finney and Ruenhoff<sup>10</sup>. They showed, as did Moynihan,<sup>18</sup> that many of the operations previously recorded as total gastrectomy were only subtotal excisions. Stahnke,<sup>23</sup> Judd, and Marshall,<sup>16</sup> Breitenback,<sup>2</sup> Flint,<sup>11</sup> Walters,<sup>20</sup> and Poole, and Foster<sup>19</sup> have since reported cases. In one of the cases reported by Moynihan,<sup>18</sup> anæmia developed after removal of the stomach. The case reported by Hartman<sup>13</sup> was suggestive of pernicious anæmia. Other similar cases have been reported, the most recent by Poole and Foster<sup>19</sup>.

*Methods of experiments*—Dogs were used for all our experiments. Operations were carried out under ether anæsthesia, and with sterile technic. In the earlier experiments gastrectomy was performed according to the method of previous investigators. Our results were complicated by the same error noted in most of the previous investigations, that is, all of the stomach was not removed. It is relatively easy to remove all of the stomach of a dog, except a narrow rim of the cardia, but total gastrectomy is difficult. The reasons for this are (1) The transition between œsophageal mucosa and cardiac mucosa usually occurs so near the line of attachment of the diaphragm around the œsophagus that when all of the stomach is removed the pleural cavity must be entered to secure sufficient length of œsophagus to suture, fatal infection of the pleura almost always occurs, (2) the blood supply to the lower end of the œsophagus and thus to the line of suture is scanty,<sup>20</sup> and, furthermore, the main arteries of this segment are sectioned in removing the stomach, (3) the œsophagus is not supplied with true serosa, (4) action of the diaphragm tends to separate the sutures, (5) the weight of the anastomosed duodenum on jejunum also tends to pull the suture line apart, and (6) as pointed out in a previous article on surgery of the œsophagus by Saint, and Mann,<sup>21</sup> operative procedures on the œsophagus do not inhibit peristalsis, and the frequent act of swallowing keeps the suture line on a more or less constant strain.

As noted in our earlier experiments, a small amount of cardia was almost invariably found at necropsy. In some experiments this tissue, which had been ignored at operation, had become enlarged and distended so that at necropsy several years after operation, the gastric cavity would contain 100 to 200 cubic centimetres of fluid (Protocol I)

After having made observations extending over several years on animals that were supposedly gastrectomized, only to find that a small portion of the cardia remained (Protocol II), a technic was developed which permitted the successful removal of all gastric tissue. This technic is similar in purpose but different in execution to that described by Heuer, Andrus, and Bell<sup>14</sup> for removal of carcinoma of the cardia. Briefly, the operative technic and post-operative treatment which overcome the difficulty of total gastrectomy in the dog are as follows:

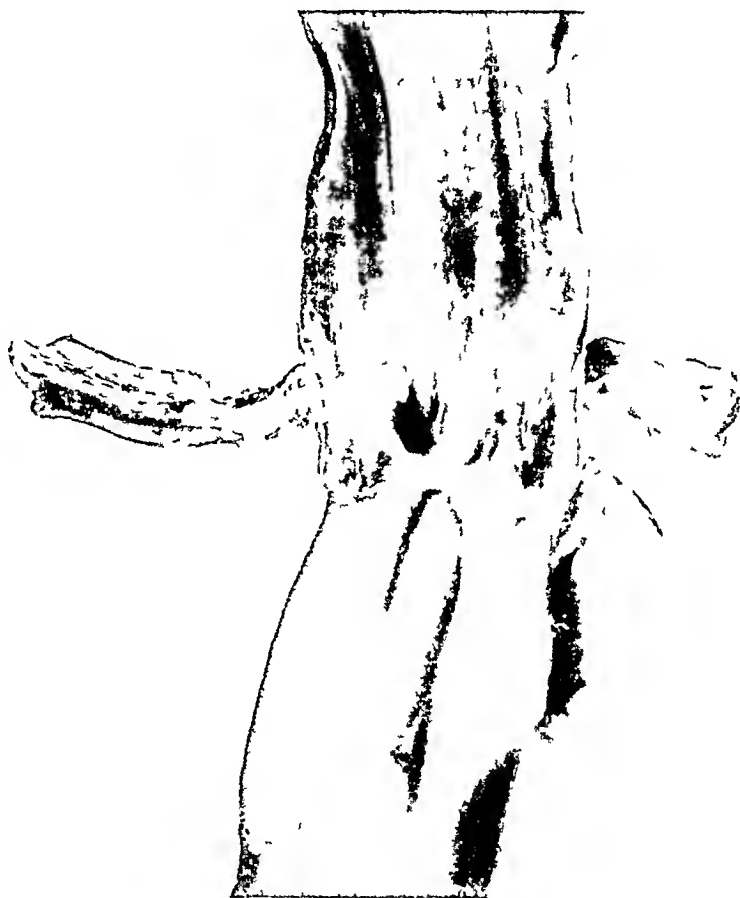


FIG. 1.—Esophageal duodenal anastomosis secured sixty five months and three days after operation. It may be noted (1) Anastomosis is just caudal to attachment of diaphragm (2) neither tube is dilated, and (3) the distance between the anastomosis and the opening of the common bile duct is short.

The operation is carried out in two stages. In the first stage the diaphragmatic attachment to the œsophagus is cut away and as much of the œsophagus as possible is pulled into the abdominal cavity. The diaphragm is then sutured around the œsophagus. After permitting sufficient time for complete healing, the abdomen is again opened, the stomach is removed completely, and the duodenum is anastomosed end-to-end to the œsophagus. The animal is prevented from taking anything by mouth for a week. Fluid and food are supplied by the intravenous administration of a sodium chloride solution with glucose twice or more daily. In the second and third weeks after

operation, milk and syrup are given by mouth at frequent intervals. At the end of the third week, solid food can be given safely.

Following these procedures six animals were observed for periods varying from one and a half years to almost six years. The actual time the animals were observed after total removal of the stomach was, respectively, as follows: eighteen months, twenty-five months and four days, thirty-nine months and four days, forty-eight months, sixty-five months and three days (Fig. 1), and seventy months and twelve days (Protocol III).

We had intended originally to carry out several observations on these animals as regards possible changes in the constituents of the blood, and so forth. However, in view of the importance of the possible relation of gastric function to pernicious anæmia, it was determined not to complicate the experiments, but to make frequent blood counts and estimations of hæmoglobin, together with such general observations as could be made without detracting from the value of the main object of the experiment.

**RESULTS—General observations—**The animals always lost weight immediately after operation, which was to be expected in view of the fact that they were not given a maintenance diet until the end of the third week after operation. Within a few weeks after being given a generous diet they regained their weight. No change in their general condition could be attributed to the loss of the stomach, the changes that did occur were those which occur if dogs are maintained over long periods in the laboratory. It was found that a cereal mash cooked in the laboratory and fed as a routine to laboratory animals three times a week, was not tolerated very well by the animals without a stomach. Their diet consisted mostly of milk, syrup, horsemeat, and commercial dog biscuit. As the animals were kept indoors, cod-liver oil was given occasionally.

Because of our special interest in these experiments, we probably gave our animals more careful attention than other animals in the laboratory, although our intention was to attempt to maintain them under identical conditions. It was our impression that an animal without a stomach probably would not maintain itself as well as a normal animal under the normal conditions of a dog outside the laboratory. However, in the laboratory, a dog without a stomach was more easily maintained in good condition than an animal with greatly reduced hepatic tissue. No change in the hunger mechanism was noted. The gastrectomized animals would bolt their food like normal dogs. For the first few months after operation the dogs were fed three times a day, but later only once. At first there was a tendency to regurgitate food more frequently than by the normal dog, but even this was not noticeable after a year or so following gastrectomy.

Observations with the Röntgen-ray and barium meal showed that the food passed immediately from the œsophagus through the duodenum and jejunum into the ileum. The passage of the food from the œsophagus into the small intestine was so rapid that we were never able to obtain a picture that did



not have food in the jejunum even if only a small amount of food was given and the picture was taken immediately

In none of the animals was there any dilatation of the duodenum. Consistent changes in either the size of the intestine or the thickness of the muscularis were not observed.

*Observations on the erythrocytes and hæmoglobin*—Changes in the blood simulating pernicious anæmia did not occur. In most of the animals the erythrocyte count, the character, size, and so forth, of the erythrocytes and hæmoglobin, remained normal throughout the period of observation. In only two of the animals did secondary anæmia develop. In one of the animals the anæmia was due to continual bleeding from infectious sarcoma. In the other animal low intestinal obstruction developed which was associated with anæmia. We do not believe that the loss of gastric tissue was responsible for the anæmia of either animal.

*Pigmentation of the intestine*—Only one positive observation was noted in the entire series of gastrectomized animals. After the stomach had been removed for a few months, it was observed that the entire small intestine became a dirty brown color. This pigment began at the suture line of the duodenum and œsophagus, and extended to the large intestine. The latter was only slightly involved. The discoloration was not due to the loss of the stomach from the body but to the lack of gastric secretion in the intestine because it also occurs in loops of intestines in animals in which the gastric secretion is shunted away from certain portions of the intestine, but the biliary secretion is permitted to reach them. The color of the pigment fades quickly and only a small percentage survives the usual histological technique. It has therefore been difficult to determine its exact site. However, pigment has been observed in the histocytes in all of the histological structures of the intestine of the gastrectomized dogs, but the main portion of the pigment appears to be situated in the muscle cells of the muscularis.

*Comment*—The results of these experiments require proper valuation. In general they merely prove that a dog may live in good health under the condition of the experiment for more than half its normal life, without gastric tissue. In this respect the results of the investigation give more encouragement if more is needed for the total removal of the stomach in the human being when such procedure is indicated. However, our results do not necessarily disprove a relation between loss of gastric function and anæmia. They do show that if such a relationship exists in the dog, this species is capable of compensation for the loss of stomach to a remarkable degree.

Simple removal of the stomach of the dog probably will not elucidate the relationship between gastric function and pernicious anæmia as indicated by studies of man. A more hopeful appearing method of investigation would be to place the totally gastrectomized animal under physiological stress as Ivy<sup>15</sup> is doing in his studies of pregnant gastrectomized dogs. But even the consistent development of secondary anæmia of gastrectomized animals which are under physiological stress, important as it is, should not be considered

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as experimental proof of a relationship between loss of gastric function and pernicious anæmia. Only the experimental production of the characteristics of pernicious anæmia will suffice. Finally, it should be noted that since pernicious anæmia has never been observed in the dog, it may not be possible to produce such a type of anæmia in this species.

*Summary*—A method for the total removal of the stomach of the dog was developed. All gastric tissue was successfully removed from six animals, and they were observed for periods varying for eighteen months to almost six years. Anæmia which could be ascribed to loss of gastric tissue did not develop in any of the animals.

*PROTOCOL I—Dilatation of a small remnant of stomach*—May 16, 1923, all of the stomach of an adult female dog, weighing 8.7 kilograms, was removed except a tube along the lesser curvature about the diameter of the œsophagus connecting the latter to the pylorus. The animal's erythrocytes and hæmoglobin were normal before operation and remained so after operation.

June 6, 1923, the weight of the animal was 8.4 kilograms. All of what was considered to be the remaining portion of the stomach was resected. The jejunum was sectioned, the distal end anastomosed to the œsophagus, and the proximal end was anastomosed to the ileum. The animal remained in good condition, maintained its weight, and the erythrocytes and hæmoglobin remained normal. Studies with a barium meal shortly after the second operation showed a small, dilated pouch which appeared to be a small remnant of stomach. Repeated observations with the barium meal demonstrated that this pouch was enlarging.

April 6, 1925, the weight was 8.5 kilograms. Exploratory operation disclosed a dilated pouch of the stomach which contained from 100 to 150 cubic centimetres of fluid. The animal was kept under observation. The pouch finally enlarged until it contained more than 200 cubic centimetres of fluid. The animal remained in excellent condition with normal weight, and normal erythrocyte count and hæmoglobin until November, 1929, when it began to lose weight and the number of erythrocytes decreased. The animal now appeared old. It had lost almost all its teeth.

January 12, 1930, the animal died suddenly. The cause of death could not be determined. The remaining portion of stomach had a capacity of 200 cubic centimetres of fluid.

*PROTOCOL II—Difficulty of complete resection of the stomach of the dog*—July 16, 1923, the stomach of an adult male dog, weighing 8.4 kilograms, was resected and the end of the duodenum was turned in. The first portion of the jejunum was sectioned, the distal end was anastomosed to the œsophagus and the proximal end to the ileum. The œsophageal jejunal anastomosis was against the diaphragm and could not have been placed any higher without entering the thorax. It could not be definitely ascertained by examination of the stomach whether all the cardia had been removed. The animal remained in good condition, and maintained its weight. The erythrocyte count and hæmoglobin remained normal, as before operation.

August 29, 1924, colitis which was prevalent in the laboratory at that time developed in the animal, and it was bled to death under ether. All organs were normal except the colon. A rim of cardiac mucosa less than 1 centimetre wide completely surrounding the intestinal tube had been left. This animal is not included in the series in which total gastrectomy was done.

*PROTOCOL III—Complete removal of the stomach with subsequent long survival of the animal in apparently normal condition*—May 18, 1925, a first-stage gastrectomy was performed on an adult male dog, weighing 10.4 kilograms. The vasa brevia were cut and ligated, the œsophagus was separated from the attachment of the diaphragm and after pulling as much of it as possible into the peritoneal cavity, the rent was repaired.

in the diaphragm. Repeated examinations before operation had shown the number of erythrocytes and hæmoglobin to be normal. The average number of erythrocytes was 5,400,000, the hæmoglobin was 80 per cent.

June 17, 1925, the animal remained in good condition. The erythrocytes and the hæmoglobin remained normal. The stomach was removed. The duodenum was anastomosed end-to-end to the œsophagus. Examination of the removed stomach showed conclusively that all of the viscus had been removed. Recovery from the operation was uneventful. During the first week after operation glucose in hypertonic sodium chloride solution was given intravenously. During the subsequent two weeks milk and syrup were given. The animal was then permitted to eat what it desired from the kennel ration. It lost some weight after the operation, which was subsequently regained. It remained in excellent condition for almost six years. During this time it was under constant observation. Blood counts and hæmoglobin estimation were taken weekly or bi-monthly. Repeated Röntgen-ray examinations with the barium meal were made. The weight of the animal remained above normal throughout the period of observation. It exhibited a tendency to get too fat at times so that a reduction of food was occasionally necessary. The fluctuations in weight from 10 to 16 kilograms were due to this variation in food intake. For months at a time the weight remained between 12 and 14 kilograms. In January, 1930, the animal began to look a little ragged and a small amount of cod-liver oil was given with its food for a few months. Owing to the loss of teeth because of age, it could not take its food as well as usual.

During the more than five years between the full recovery of the animal from the operation and within four months before it was killed, the number of erythrocytes varied between 4,400,000 and 6,400,000. The percentage of hæmoglobin varied between 75 and 100. The variation in estimation of hæmoglobin was partially due to changes in the method of estimation, as four different methods were used during the years the animal was under observation. During the four months preceding the animal's coming to necropsy, both the erythrocyte count and hæmoglobin remained a little lower than in the preceding years, although the former never went below 4,000,000 or the latter below 70 per cent. The erythrocyte count at the time the animal was killed was 4,360,000 and the hæmoglobin was 80 per cent. At no time was either below normal for the dog. The animal did not exhibit any illness until two days before it was killed.

April 27, 1931, the animal was noted quiet, which was in marked contrast to its usual manner.

April 29, 1931, the animal was very quiet and sleepy, and refused food. The urine was turbid and coffee colored. The animal was bled to death under ether, and necropsy was performed at once. The animal was in good physical condition, its weight was 12.4 kilograms. A layer of subcutaneous fat about 1 centimetre thick covered the entire body. The few remaining teeth were badly worn. The gastro-intestinal tract was normal except for the absence of the stomach, and a brownish-pink discoloration of the entire small intestine and to a large extent the colon. The line of anastomosis between the duodenum and œsophagus was in good condition, there was no stenosis or dilatation of duodenum or œsophagus. The gall-bladder was markedly distended with dark-colored bile. The urinary bladder contained a few cubic centimetres of a coffee-colored fluid. On the base of the bladder on the dorsal surface was a large, ulcerated area measuring approximately 2 centimetres in diameter. The base of this area was hard and indurated. The origin of the blood in the urine was evidently from the mucosa. All other organs, including the spinal cord, were grossly and microscopically normal.

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# CARCINOMA IN THE DUODENUM

ORIGINATING FROM ABERRANT PANCREATIC CELLS

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CARCINOMA occurring in the duodenum is an unusual condition

Carcinoma found in the duodenum proven to have originated from misplaced pancreatic cells is very rare, a fairly careful search of the literature having revealed but one somewhat similar case in which the site of the new growth was at the pylorus and involving the stomach wall as well as the duodenum

The first case of duodenal malignancy was reported by Hamburger, in 1746. His case had a carcinoma situated in the first portion which perforated, a fatal peritonitis followed. Jefferson collected reports of 109,201 autopsies from English, German, American and Swiss hospitals and found only forty-three cases of carcinoma of the duodenum or about 0.4 per cent. A statement of interest and fact is made by this author to the effect that "inch for inch the duodenum is more likely to undergo carcinomatous change than the jejunum or ileum," so that, rare as a malignant neoplasm is in the proximal end of the small bowel, it is still more rare in its distal portion.

Most of the cases of carcinoma of the duodenum reported seemingly spring from the cells of the lining mucosa and fewer from Brunner's glands, many of these cases having the history of a long-standing ulcer with ensuing malignant degeneration. The possibility of aberrant pancreatic cells being a point of origin is hinted at by many authors, but proof as to its actual occurrence is usually lacking. Bland-Sutton rather belittles this idea when he states "a consideration of tumors of the small intestine would be incomplete without reference to the suggestion that cancer of the small intestine may arise in an accessory pancreas—it is necessary to mention accessory pancreas when considering cancer of the duodenum and small intestine because those pathologists who still believe that carcinoma arises in embryonic vestiges think it probable that this perversion may arise in islands of pancreatic tissue. There is no evidence to support this theory nor that which attributes duodenal cancer to morbid changes in Brunner's glands." The actual incidence of a malignant change taking place in a duodenal ulcer is a point that is still *sub judice*.

Ewing classifies carcinoma of the duodenum as follows

(1) Carcinoma following ulcer, similar to pyloric ulcerocarcinoma which leads to stenosis and adhesions and in which class metastases are frequent and widespread

(2) Carcinoma found about the papilla of Vater, in which group jaundice

occurs early and fairly constantly—in twenty-three out of twenty-five cases quoted by Mathieu. These carcinomata are usually derived from the intestinal mucosa.

(3) Carcinoma of the third portion, or pre-jejunal carcinomata, usually associated with ulceration and stenosis.

An origin from Brunner's glands has been suggested by Orth and from aberrant pancreatic tissue by several writers. Many of the cases are difficult to separate from primary carcinoma of the pancreas.

Outerbridge states that theoretically at least six points of possible origin must be considered in carcinoma in the region of the papilla of Vater:

- (1) From epithelial cells lining the true ampulla
- (2) From cells lining the common duct at its lower end
- (3) From cells lining the pancreatic duct at its lower end
- (4) From the duodenal mucosa covering the papilla
- (5) From the glands of Brunner situated beneath the duodenal mucosa
- (6) From aberrant pancreatic acini in the wall of the common duct

*Embryology*—The formation of the pancreas is well advanced in the second month of fetal life. It springs from a hollow projection from the dorsal wall of that portion of the foregut which afterward becomes the duodenum opposite the hepatic diverticula which springs from its ventral wall. The hollow process grows between the two layers of the dorsal mesentery and by sending out offshoots which branch abundantly, eventually forms the pancreas. As torsion of the stomach takes place, the pancreas assumes a transverse position and becomes fixed across the dorsal wall of the abdomen, the posterior layer of its mesentery undergoing absorption.

From this it may be seen that in its formation some of the cells of the pancreas may have been dislocated or misplaced during fetal life and may and often do result in the formation of an accessory pancreas or aberrant pancreatic rests in or about the region of the duodenum. In our case, there must have been a plaque of pancreatic tissue under the mucosa of the duodenum separate and distinct from the pancreas proper, as it was noted at operation that the duodenum at the site of the tumor was very easily mobilized and brought up into the wound for satisfactory examination. The duodenum at this point had somewhat of a mesentery which might have been factored by traction on the bowel and the mobile peritoneum above and below followed it. Fact is emphasized to show definitely that there was no connection between the tumor found in our case and the pancreas proper.

*CASE*—Mrs. A. F., aged twenty-eight, married, was admitted to Lebanon Hospital September 17, 1930, complaining of (1) pain in the epigastrium, (2) pain in lumbosacral region radiating down left thigh.

The patient was operated on in Germany at the age of nineteen for appendicitis. Had pneumonia in 1920, 1921 and 1922. During 1927 was in a hospital in Germany and treated for ulcer of the stomach. For the past three years she has complained of pain in the upper part of the abdomen. This pain appears about two to three hours before meals and lasts until about one hour after the meal. This pain is described as drawing in character and radiates all over the abdomen. She has not complained

of sour eructations or vomiting Never noticed that her stools were dark Has been afraid to eat meat because she claims that this aggravates the pain Appetite fair Bowels occasionally constipated and diarrhoea rarely No urinary symptoms Menses regular Married nine months Perspires very freely at night Has lost ten pounds in the last four weeks Feels weak and is easily fatigued The pain in the lumbosacral region has been annoying her for the past two weeks and has been increasing in severity This pain is across her back and seems to radiate down her left thigh

The patient does not look acutely ill No cervical or axillary adenopathy

Palpation of the abdomen reveals no masses There is a sense of resistance, half of the abdomen more marked on the right side than the left Radioscopic examination of the pelvis discloses arthritic changes involving both sacro-iliac synchondroses with slight broadening of the right

Fluoroscopic examination shows the stomach to be "J" shaped, normal in contour and moderately ptosed Duodenal bulb is incompletely filled The first portion of the basal region of the cap shows a circumscribed clear shadow due to displacement of some barium A re-examination shows this same filling defect Six hour film showed no gastric residue Head of opaque meal at the hepatic flexure, tail in terminal ileum There are a few flakes of barium in the first portion of the duodenum Films taken at these examinations reveal the same findings as the fluoroscopy

*Conclusions*—Combined radioscopic and fluoroscopic examination of the upper gastro-intestinal tract disclose the presence of an organic lesion in the first portion of the duodenum the characteristics of which suggest that the lesion is probably a benignant tumor, such as a polyp Gastric extraction, free HCl, 0, total HCl, 17

Urine, blood, sputum and examinations negative

Operation September 30, 1930 Gas-oxygen-ether anaesthesia Upper right rectus incision No free fluid found on opening the peritoneal cavity In the first portion of the duodenum and within the first inch of this structure there is a small mass palpable within the wall of the bowel This is circular in outline and about one and a quarter centimetres in diameter Seems to be firmly attached to the duodenal wall at its antero-inferior aspect Just below this structure there is some puckering of the peritoneum on the duodenal wall which extends downward toward the pancreas The duodenum can be lifted well away from the pancreas and an artificial mesentery created by traction, this artificial structure contains no glands and is very thin

In order to examine the tumor more thoroughly an incision was made in the normal duodenal wall and lengthened so as to include the pylorus and some of the stomach wall The tumor was now turned out through this incision and found to be a smooth, disc-like structure about a half centimetre in thickness It was covered with mucous membrane which was not ulcerated The mass itself was firmly embedded in the duodenal wall and was practically immobile The mass seemed hard and did not fluctuate The tumor was excised by a circular incision well away from its margins During this procedure the mass, which was a cyst, ruptured The walls of the cyst were about one quarter centimetre in thickness and it had a smooth-lined cavity The fluid which escaped into the protecting laparotomy pads was light brown in color and contained some brown, dustlike particles

The rent made by the excision of the tumor was closed, as was the incision made in the bowel to inspect the tumor The duodenum, as the result of this suturing, seemed somewhat narrowed, so a gastrojejunostomy was made No glands were palpated at any time Abdomen closed

Microscopic section of the material removed shows mucosa infiltrated with numerous red blood-cells which have formed a rather thick layer on the surface and extend down between the glandular elements to the submucosa The muscularis is normal but in the outer coat of the latter are numerous discrete and confluent islands composed of simple round bound together with small strands of connective tissue These islands or nests resemble the normal pancreatic tissue but there are no islands of

## CARCINOMA IN THE DUODENUM

Langerhans In some areas there is breaking through of the muscle fibres and the cells of the acini mentioned are growing in a wild disordered manner The serosa is infiltrated and covered with blood

*Diagnosis*—Carcinoma of the duodenum, probably secondary to pancreatic rest

The only other case that approaches the pathologic aspects of this case is the one reported by Branham This case is cited by Deaver and Ravdin as having been published in 1913, Jefferson giving the date as 1903 It appeared, however, in the Maryland Medical Journal in 1908 Branham's case is one of a growth at the pylorus involving the stomach wall as well as the first portion of the duodenum A pylorotomy was performed The sections were seen and attested to by Welch as originating from pancreatic tissue Patient was reported well and free from symptoms nine years later

A point of great diagnostic significance is gleaned from many reported histories of cases of carcinoma of the duodenum, *ie*, the stomach analysis in a very large number shows a very low acidity or complete absence of free hydrochloric acid, this obtained in our case The importance of this sign is that, given a case which clinically may be considered one of ulcer, and the gastric analysis shows a lowered or totally deficient acid content, the diagnosis of a carcinoma must be well considered and a good X-ray examination made to complete the picture for diagnosis previous to a radical resection of the ulcer

In this case a malignancy was not suspected and it was not until the pathologic report was returned that the true nature of the condition was disclosed A sub-total resection of the duodenum and adjacent stomach might have been made at the time had the real state of affairs been known, or suspected but the patient left the hospital and only consented to remain under observation by her family physician, who has reported a marked gain in weight and strength

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## BRIEF COMMUNICATIONS

### CARCINOMA OF THE HEPATIC DUCT

WYLEGSCHAN<sup>1</sup> was able to collect a total of thirty-four cases of primary carcinoma of the hepatic duct in the literature and adding one additional case brought the total to thirty-five. Since 1927 one case has been added.<sup>2</sup>

This group of carcinomas are slow to metastasize. To some extent this is probably the result of early fatal secondary injury by biliary obstruction. They are generally adenocarcinomas which occasionally display a predominance of fibrous reaction (scirrhus type). The largest reported (Wylegschan) was the size of a pigeon's egg. Biliary obstruction, with obstructive jaundice progressive in type, and death from cholæmia and liver insufficiency, and finding of dilated bile-ducts above the obstruction are common. Portal cirrhosis is an occasional concomitant finding as are gall-stones. The gall-bladder and ducts below the tumor are usually contracted although in Wylegschan's case the gall-bladder and common duct were distended with blood-stained mucoid fluid.

A white male, fifty-three years of age, was admitted to the Research and Educational Hospitals on the medical service of Dr. C. S. Williamson, July 8, 1931, complaining of progressive jaundice, six weeks' duration, and weakness for the same period of time associated with a loss of 22 pounds. He stated he had been suffering from stomach trouble, characterized especially by distension and discomfort after meals, for a period of five years.

Eight weeks prior to admission he noticed that his urine was extremely dark and shortly thereafter he noticed jaundice of the skin and a severe sharp pain in the epigastrium radiating posteriorly to the mid-scapular region. The epigastric pain disappeared spontaneously in a few days, but the pain in the back persisted to the day of admission. Four of five clay-colored stools a day were noted and progressive weakness complained of. His appetite has been good, although he abstained from meats and fats because he noted increasing darkening of the urine following these foods. A light-brown stool was said to have been passed a few days before admission.

On physical examination a marked jaundice was noted and the loss of weight was apparent. Neither the liver nor the spleen was palpable, although the abdominal examination was not entirely satisfactory because of poor cooperation. The stools were clay-colored with chemical blood demonstrable. The blood sugar was 86, the icterus index 117. Bile was present in the urine in large quantities. The white count was 13,850 with 83 per cent polymorphonuclears.

After suitable pre-operative preparation and with a diagnosis of obstructive jaundice on the basis of the carcinoma of the head of the pancreas, an exploratory laparotomy was undertaken on the 23d of July by one of us (Dr. J. D. Koucky).

At this time the gall-bladder was found to be markedly distended as was the common duct. On opening the latter, it and the gall-bladder were found to be filled with white bile. The entire length of the common duct, including the opening into the duodenum, was widely patent and free from obstruction. On palpating the hepatic duct, however, a

<sup>1</sup> Frank Furter, *Zeitschrift für Pathologie*, vol. XXXI, pp. 417-433, 1927.

<sup>2</sup> Vander Veer, Edgar A., and Nelms, H., *ANNALS OF SURGERY*, vol. LXVIII, pp. 157-159, 1928.

## CANCER OF THE HEPATIC DUCT

rather poorly localized indurated area was found near the exit from the liver, in which region the duct was found to be obstructed on exploration with a probe. The stricture was dilated with a curved forceps and a small amount of tissue was removed with a curette. A small amount of white bile was obtained from the duct above the stricture. A catheter was placed in the bile-ducts from a point above the tumor through the ampulla. The duct was closed.

The patient was returned to the ward in good condition, and in the next two days complained of little pain but vomited large amounts of dark-brown material.

On the 26th of July vomiting became more persistent, pulse became weaker, and on the 27th, after a period of hiccoughing and marked vomiting, the patient died. The temperature at no time exceeded 100.4°.

At autopsy an area of consolidation 2 centimetres in diameter was found in the right pulmonary lobe. The myocardium showed moderate evidences of degeneration and the kidneys showed the usual picture of cholæmic nephrosis. The stomach was dilated and filled with very dark-brown fluid, about 1,500 cubic centimetres in amount. A rubber catheter was found free in the ileum. The liver weighed 1,800 grams, the surface was granular, dark green, the consistency firm, and the cut surface was deeply bile-stained with dense, gray-green, trabecular markings and intervening islets of proliferating parenchyma tissue.

There was a tumor of the hepatic duct about 1 centimetre from the origin in the liver measuring about 2 centimetres in length, and about 1½ centimetres in diameter. On opening the duct in this region it was found to be widely patent and the surface roughened. On cut section of the liver, the widely dilated bile-ducts were found filled with white mucoid, glistening material and here and there ½ to 1 millimetre-sized focal gray to yellow softened areas were seen.

The gall-bladder was markedly dilated and thin walled and contained about 200 cubic centimetres of the same white bile and the common bile-duct was widely dilated. The opening through the papilla of Vater measured 3 millimetres in diameter and above this point the duct was 5 millimetres in diameter. Except for the localized post-operative changes no other findings of note were present.

Microscopically, both the curettage specimen obtained at operation and the section of the tumor obtained at the autopsy revealed an adenocarcinoma of a low-grade malignancy.

In sections of the liver the parenchyma cells were moderate in size and generally well preserved. They contained a large amount of golden granular pigment. The Kupfer cells were prominent, swollen, and the majority of them filled with brown, coarsely granular pigment. The periportal connective tissue was markedly increased in amount and the seat of a pronounced round-cell infiltration, in focal areas abscesses of miliar type, made up of polymorphonuclears with little connective tissue, were prominent. Sections of the gall-bladder and common duct revealed atrophy of the muscular elements in the markedly thinned-out wall and showed no inflammatory changes.

Important features to be emphasized in this case are first, the recording of an additional primary carcinoma of the hepatic duct in literature, second, the unique method of surgical attack employed for treatment and diagnosis, namely, dilatation and curettage of the hepatic duct, and finally, the changes noted above and below the point of obstruction and certain physiological aberrations connected with these changes.

The fact that bile was found in the Kupfer cells emphasizes the independent rôle of excretion from that of the formation of bile, and the failure of restoration of this function following long-continued obstruction can be explained only on the basis of the effect of the long-continued pressure on the excretory function of the liver cells. The short period of time between

the relief of obstruction and the death of the patient, namely, four days, is not long enough to entirely evaluate this factor. However, it is apparent that the restoration of this function once lost must require a considerable period of time.

Finally, a marked dilatation of the gall-bladder by mucoid material, so-called white bile, and the similar dilatation of the common duct below the point of obstruction demands an explanation.

From a morphological standpoint, atrophy of the muscular elements was noted. The fact that these parts were filled with a mucoid material would indicate that bile in itself must offer an essential stimulus to the rhythmic emptying of the gall-bladder and the muscular contractions of the common duct.

In conclusion, there may be emphasized that there is apparent dissociation of the functions of formation and excretion of bile in so far as the liver is important. The abolition of the function of excretion resulted in this case from long-continued obstruction by a carcinoma of the hepatic duct. The relief of this obstruction for a period of four days was insufficient to allow restoration of the excretory function, a phenomenon not infrequently encountered following relief of any type of continued obstruction.

We should like to emphasize further the fact that mere distension of the gall-bladder by mucoid material was not sufficient, apparently, to induce that organ to empty itself, and as an apparent result of the lack of normal physiological stimulus, namely, the presence of bile, there was marked dilatation of both the gall-bladder and the common duct in the absence of any obstruction in either the cystic or the common ducts.

*Summary*—(1) An additional carcinoma of the hepatic duct is added here to the thirty-six already recorded in the literature.

(2) A unique method of surgical diagnosis and treatment was resorted to, namely dilatation and curettage of the hepatic duct.

(3) Emphasis is placed upon the failure of the liver to excrete bile during the four days following the operation.

(4) Marked dilatation of the gall-bladder and common duct are explained by the lack of bile, the physiological stimulus with the emptying of this organ.

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## SUBUNGUAL MELANOMA IN NEGROES

MELANOTIC tumors of all types are very rare in the Negro. Adair, Pack, and Nicholson<sup>1</sup> in a review of the literature on this subject found fourteen reported cases up to 1926. One of three cases of subungual melanoma which these authors observed at Memorial Hospital occurred in a Negro. In 1927 Bauer<sup>2</sup> reported two cases of melanotic tumors occurring in Negroes, one of which was a subungual melanoma. We can now add a further case to those already reported.

## SUBUNGUAL MELANOMA IN NEGROES

A Negress, seventy-three years of age, came to the Cleveland Clinic complaining of discoloration of the fifth finger of the left hand. The following history was obtained. For twenty years she had had a "black spot" on the nail of the fifth finger of the left hand. This spot grew gradually larger and another developed, so that there were two large discolored areas on the nail, both quite black in color. This condition had remained constant for the past fifteen years, during which time the area of discoloration had not increased in size. Six months previous to the admission of the patient, the nail split, assuming a bifid character. Up to that time the nail had been normal in shape and configuration (Fig 1).

Physical examination of the patient revealed nothing abnormal apart from the black discoloration of the fifth finger of the left hand, including the nail which was bifid due to a splitting down its centre as far as the nail bed. Pus could be evacuated from the central split down the nail. The palmar aspect of the tip of the finger presented an area of dark, gangrenous-appearing skin. No enlarged regional lymph-nodes could be detected.

Clinically, the lesion was thought to be an infected, melanotic, pigmented tumor, the exact pathological nature of which could not be determined. Microscopical examination of a small piece of tissue from the nail bed showed that the tumor was a subungual melanoma of low-grade malignancy.

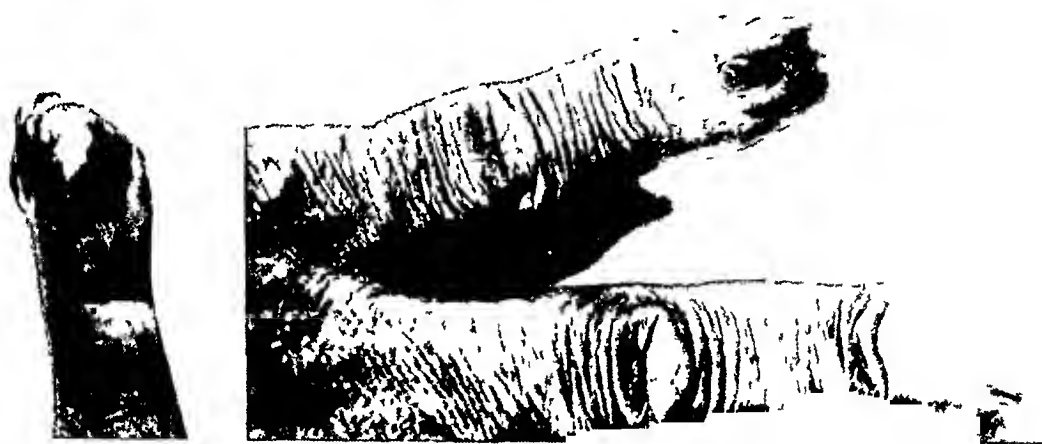


FIG 1.—Photograph of fifth finger of left hand, showing subungual melanoma.

The finger was amputated at the metacarpo-phalangeal joint and the head of the metacarpal bone was removed. The wound healed by first intention.

The following is the report of the microscopical examination of the removed tissue.

"Section of tissue through the nail bed shows thickened epidermis covered by a heavy layer of keratohyaline material in the region of the base of the nail. In the region of the tip, the epithelium is destroyed, the tissue is ulcerated, and in the deeper layers there is a large quantity of very cellular tissue rich in melanin pigment. In some areas the quantity of melanin pigment is large and the number of actively growing tumor cells is small. This is particularly true of the area near the base of the nail. Near the tip of the finger the tumor cells predominate over the pigment. The vast majority of the cells, however, contain fine, granular, dark-brown pigment in the cytoplasm. The tumor cells are quite large, some are multinucleated. Mitotic figures are rare" (Fig 2).

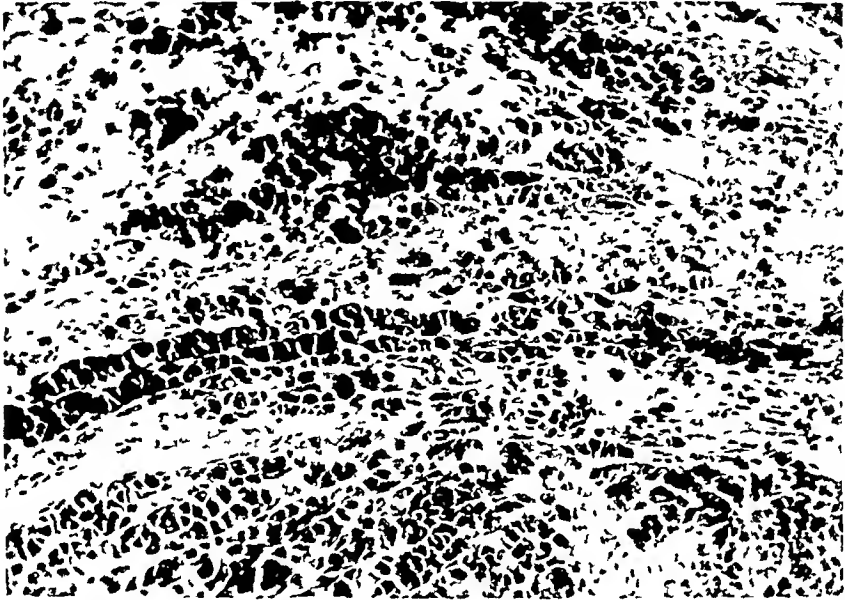
*Second Pathological Report*—"Longitudinal section through the distal phalanx, including the nail, soft tissues and bone—which has been decalcified—shows keratosis of the nail bed and ulceration of the tip of the finger. Considerable diffuse inflammatory reaction is present in the soft tissues. There is no involvement of bone. A large amount of melanin pigment may be observed below the epidermis under the tip of the nail. The melanin-forming cells show very little evidence of active growth."

The pathological diagnosis was *subungual melanoma* of low-grade malignancy. The

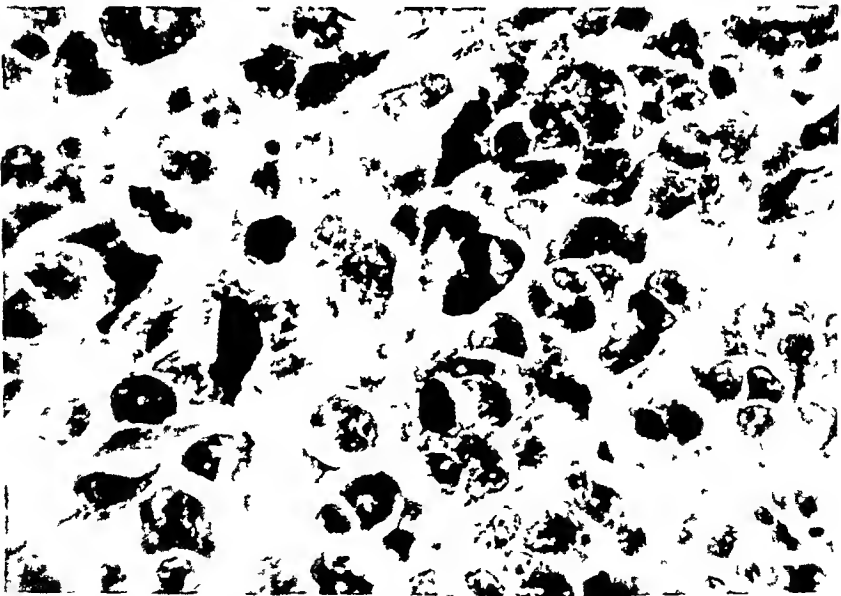
## BRIEF COMMUNICATIONS

patient was instructed to return to the clinic at frequent intervals for examination but she neglected to do so. She was visited July 20, 1931, ten and a half months following the removal of the finger. The amputation scar was found to be in perfect condition and there was no evidence of any neoplastic process.

The left epitrochlear and axillary lymph glands, however, were definitely enlarged



A



B

FIG. 2.—A—Photomicrograph of subungual melanoma ( $\times 150$ ). B—High power photomicrograph of same area of tissue as shown in A ( $\times 600$ ).

and hard, but not fixed. The patient was in excellent condition and had not noticed the presence of the nodules in the left epitrochlear and axillary regions.

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## CANCER IN NEW YORK CITY

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## ADRENAL NEUROBLASTOMA IN INFANCY—15 YEAR SURVIVAL

IN the Journal of Medical Research for May, 1917, vol xxxvi, No 2, I reported a case of adrienal tumor under the designation of neuroblastoma This tumor had been removed by Dr Willard Bartlett, of St Louis, from an infant of eleven months The tumor was a typical example of its type and relatively undifferentiated

The following paragraph occurs in the original report "This case is distinctive among undifferentiated tumors in one respect that deserves mention It is the first case successfully operated upon Although theoretically one cannot avoid the feeling that evidence of metastasis may occur, yet two and one-half months after operation the child's health continues to improve All other cases that have come to operation have died during or shortly after the operative procedure" Since then other cases have been successfully operated on, including one in this clinic recently by Dr William H Goodwin

The present note is made to put on record the fact that Doctor Bartlett's patient has survived for fifteen years He has recently been seen by Doctor Bartlett who says that he is in perfect health

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## CANCER IN NEW YORK CITY

THE weekly bulletin of the Department of Health of the City of New York dated November 1, 1931 gives the following statistics as to cancer in New York City With the permission of Dr Shirley W Wynne, Commissioner of Health, they are submitted herewith in the belief that they are of sufficient importance, by reason of their completeness and their extent, to warrant their introduction in any general review of the subject of cancer

The New York City cancer committee is carrying on a campaign of education to call public attention to the menace of cancer and to rouse the people to an appreciation of the significant signs and symptoms which may indicate cancer in its early stages Chief emphasis is laid on the importance of early diagnosis and on the danger attending failure to consult a qualified physician

The number of deaths from cancer in New York City has steadily increased in recent years From only 78 per 100 000 of population in 1910 the deaths have risen to 117 per 100 000 in 1930, an increase of 50 per cent in the twenty years The actual number of deaths in New York City from this cause in 1930 was 8025

This increase is due to several factors—more accurate statistics, better diagnosis, and greater average age reached by the population, which puts a larger number of people into the middle-age group, *i e*, the cancer age. The result of all these factors is that in 1930 the deaths from cancer in New York were outnumbered only by those from heart disease.

Unfortunately, since cancer is not a reportable disease, the available statistics cover only the mortality. The number of cases successfully treated cannot be computed. If all the facts were known, cancer would probably be found to be even more prevalent than is at present realized, but it would also be seen that by early discovery and prompt and proper treatment cures can be affected.

That cancer is becoming more important as a cause of death in New York is shown by comparing the leading causes of death in 1910 and in 1930. In 1910, pneumonia was the most frequent cause, with 220 deaths per 100,000 of population, pulmonary tuberculosis was second, with 182 deaths per 100,000, and heart disease third, with 144. Cancer was fifth on the list, causing 78 deaths per 100,000 of population during that year.

By 1930, however, cancer had risen to second place, with 117 per 100,000 of population, an increase of 50 per cent. Pneumonia, tuberculosis and nephritis, on the other hand, all showed marked decreases.

Although there are more men than women in New York City, the deaths from cancer among females exceed those among males. In 1930, this difference was more marked in the age groups between twenty-five and sixty-five. Before the age of twenty-five the difference was less, although the deaths of females were more frequent. After the age of sixty-five, the balance changed, more men than women dying from cancer, in spite of the fact that the total number of women living in that age group was considerably in excess of men.

In 1930 the female death rate was 122 per 100,000 as compared to 111 for males.

The stomach and the liver are the most frequent sites of fatal cancer. Last year, in New York City, there were 2,605 deaths from cancer of these organs, 1,429 in men and 1,176 in women. In addition, there occurred 1,435 deaths from cancer of the intestines and rectum, 704 in men and 731 in women, making a total of 4,040 deaths in both sexes due to cancer of parts of the digestive system.

Cancer of the breast and genital organs caused 1,841 deaths, by far the largest number, 1,610, occurring in women. Cancer of the kidneys and bladder, on the contrary, is more common among men, as are cancer of the lungs, cancer of the buccal cavity and cancer of the skin.

Cancer of the skin caused 66 deaths among men and 40 deaths among women, most of which should have been prevented, as cancer of the skin is visible, accessible, and in its early stages usually curable by surgery or radiation. In these tumors the relation between chronic irritation and the development of the growth is very clearly shown and it should be possible to prevent a large proportion of them.

LEWIS S. PILCHER

## BOOK REVIEWS

CANCER DU PANCREAS BY CH OBERLING AND M GUERIN Octavo, pp 363 Paris, Gaston Dion & Cie, 1931

THIS volume on CANCER OF THE PANCREAS is the final volume of the series published under the direction of Professors Hartman and Berard, completing a series of ten volumes in which cancer of various regions of the body has been considered, those thus far treated being the intestines, the kidney and urinary passages, the rectum, the thyroid gland, the uterus, the visual apparatus, the œsophagus, the nasal passages and bones, thus forming a library of the highest value and most thorough and comprehensive character

Of the series, this one devoted to the pancreas is peculiarly timely and important due to the obscure nature of the earlier symptoms of the disease, the difficulties of diagnosis and the apparent impossibility of satisfactory treatment. Dead-house statistics have given an average of three cancers of the pancreas to every 1,000 autopsies. As to its frequency in comparison with other malignant tumors, different observers differ in their estimations, from three to twenty-three per 1,000 of which figures the lowest are probably nearest the truth. As to sex, the percentage among men is almost double that among women. Although tumors of the pancreas had been recognized at various times, it was not until 1888 that the diagnosis of pancreatic cancer was placed upon a satisfactory basis by the researches of Baid and Pic. The present treatise brings our knowledge with regard to this seat of cancer fully up to date and must be considered as a valuable contribution to the subject.

In its normal state, the pancreas does not lend itself to abdominal palpation. Of all the organs of the abdominal cavity, it is the most fixed. The head is especially difficult of mobilization. Its secretion is double in its function, internally discharging into the blood a substance without which the organism cannot make use of glucose, externally when emptied into the duodenum as a pancreatic juice, it exerts specific digestive influences upon fats, hydrocarbons and proteins. As to the development of cancer within its substance, it is not free from the conditions in other parts of the body in which the development of cancers is well understood to be preceded by chronic inflammatory conditions. The authors make the general statement that the first question which has to be settled in cases of cancer of the pancreas is by what chronic inflammatory lesion has it been preceded, what has been the origin of the chronic pancreatitis which has now become complicated with cancer? The intimate relation between the pancreatic ducts and the excretory ducts of the liver and the gall-bladder must inevitably obscure the pancreatic involvement by the preceding and major biliary symptoms. The natural



result is that cancer of the head is much more frequent, from 70 to 80 per cent of all cases belonging to that class. Later, however, the symptoms due to the pancreatic tumor dominate the scene although the gall-bladder may be largely distended and the liver enlarged. In the later history of cancers of the head, the organs situated in the epigastrium, namely, the liver, the duodenum, the stomach and the transverse colon, are all bound together with the pancreas by numerous adhesions which solidly fix the mass to the posterior wall of the abdomen. Cancers of the body invade very rapidly the retro-pancreatic connective tissue involving especially the vessels and nerves. Involvement of the portal vein is frequent. Considerable contractions of the aorta and vena cava may be produced, branches of the celiac plexus become compromised and atrophy. The predominance of ascitic infections and crises of pain are the special accompaniments of this form. The cancer, wherever it may primarily be localized, extends often to the neighboring parts of the organ, even to its totality. Secondary alterations from necrosis and hæmorrhages are frequent. The formation of extensive adhesions takes place early. The tumor becomes attached and fixed more and more in the pre-vertebral plane the stomach is almost always involved in the adhesions. The duodenum is habitually solidly fixed, the gall-bladder, the transverse colon and certain parts of the small intestine may be involved in the adhesions. Metastases are almost constant in the regional ganglia and in the liver, more rarely in the lung.

The pancreatic cancer may be of secondary origin as a direct propagation from a malignant tumor of the neighborhood. Cancer of the pancreas is essentially, in its earlier development, a latent process. One sign, however, belongs properly to it namely, intense and rapid denutrition. Later, various symptoms arise from its extension due to compression and invasion of neighboring organs. Jaundice, which accompanies cancer of the head of the pancreas is very light at first, gradually progressing until it attains an extraordinary intensity. A persistent diarrhoea associated with jaundice always awakens the suspicion of cancer of the head of the pancreas. The failure to digest fats is a well-known sign. Emaciation is intense and rapid. It is rare to be able to perceive any tumor by palpation. The disease progresses continuously the digestive troubles increase, the emaciation becomes more accentuated the fatal end supervenes at the end of a few months, possibly accelerated by such accidents as hæmorrhages cardiac failure and pleuropulmonary affections. The pain which is a capital symptom of cancer of the body of the pancreas is felt most frequently in the epigastric region. Often it radiates to the back or even to the iliac region. This pain comes on almost always in the form of crises which supervene apparently without cause. They are of short duration but of frequent repetition. The digestive symptoms are frequent and intense including anorexia repugnance to fatty matter, frequent vomiting. The symptoms of cancer located in different sections of the pancreas are often so complicated in their manifestations as not to fall

under any one form of classification. Sometimes when the symptoms may correspond to one of the forms, the autopsy will demonstrate a different location. Atypical forms are also met with in cases differing totally from the classical forms. Thus, the symptoms due to digestive troubles, enlargement of the liver, ascites, vary to a degree that may suggest other organs as the seat of the disease rather than the pancreas. A very marked glycosuria may be present. Gastro-intestinal symptoms sometimes predominate, ascites may take on considerable proportions, becoming the chief manifestation, a renal syndrome may be supreme. In some cases, the pancreatic symptoms are so latent as to escape detection until an intercurrent disease has occasioned autopsy.

After these observations as to the symptoms and effects of the disease, it is to be expected that the consideration of diagnosis might receive considerable discussion. To the subject of diagnosis over forty pages are devoted. Quite a minute analysis is given of the various functional as well as symptomatic conditions that the various forms of the affection may present.

Concerning the subject of treatment, the efforts which have been made to the surgery of these conditions are considered at some length. For the last half century the efforts of treatment have been directed along the line of surgery, notwithstanding that anatomical conditions are such as to render operative interference so very difficult. Numerous experimenters have been able to practice partial and even complete ablations of the pancreas in the dog. In man the total removal of the pancreas, even if operatively possible, should be interdicted, because of the fatal diabetes which would follow such removal. It is agreed among surgeons that ablations should not exceed 50 per cent of the total bulk of the gland. The operative difficulties will vary according to the segment of the pancreas with which the operator has to deal. The removal of the tail and of the body are relatively easy. The head, however, is deeply fixed posteriorly and encircled by the duodenum, covered by the root of the transverse mesocolon and involved among important blood-vessels. Its removal is not only laborious and delicate but involves the section of part of the duodenum and division of the ductus choledochus and the canal of Wirsung. The disposition of the fluids of these canals is always a problem involved. Perfect asepsis is absolutely necessary with careful toilet of the abdominal cavity and the operative field. Various methods of operative technic are described and fully illustrated by a series of plates.

Extracts from literature are given, containing the operative results obtained by many surgeons. Records of partial pancreatectomy are available in more than twenty-five cases. These show that while an operative attack more or less radical may be possible, thus far in all cases ultimate death has followed from recurrent disease. Thus, in two cases of duodenopancreatectomy which are given, in one case operative recovery took place but death on the twenty-fourth day thereafter followed from glycosuric cachexia. In the second case, the operator was unable to complete the opera-

tion and made a second attempt later, at which time the patient died of the operative shock. This statement, however, is modified by the remark that the totality of the resection is very doubtful in these cases. The first case is believed to be one done by Billroth in 1882, but its details are so defective that the case remains doubtful. In the second case, a woman, sixty-eight years of age, the surgeon (Franke) is stated to have taken away the entire gland, a small supernumerary pancreas, however, having been left behind. The patient suffered from glycosuria for three weeks post-operative, and finally succumbed to a general cancerous diffusion five months later. In cases where cancer is very extensive and there are present also metastases in the liver or elsewhere, palliative treatment alone is practicable. One author (Swan) estimates that scarcely 4 per cent of pancreatic cancers when detected are limited enough to justify efforts at their total removal. Heiberg basing his opinion upon thirty-five personal cases, claims that metastases exist almost always at the time of intervention. Palliative operations may be required by intestinal obstruction or biliary retention, which conditions are to be met by appropriate measures. The results are not very encouraging, survival being secured for only from a few days to six to eight months at most. A large mortality attends such operative palliative efforts.

Operations should not be considered when there exist signs of generalization or symptoms of serious hepatic and pancreatic insufficiency. In other cases an exploratory laparotomy will permit the determination of the lesions, the appreciation of their extent and the limits of operability. In a patient who presents a tumor apparently quite limited and of small extent, radical treatment might be attempted. Most frequently, however, the advanced condition of the lesions and especially the general state of the patient will oblige the surgeon to confine himself to palliative attempts or to close the abdomen without any operative manoeuvres whatsoever. Practically those cancers alone are possible of extirpation which are localized in the gland itself but experience has shown that the invasion of the gland is always much more extensive than the primary examination would lead to suppose and that partial pancreatectomy is promptly followed by recidive in most cases. The proportion of cancers in which radical treatment is justifiable therefore is very small. The attempts at treatment by radium are still too few and recent to make a positive judgment practicable. A very extensive bibliography concludes the book.

The book as a whole with its 330 pages of text and many illustrative cuts produces a volume of great interest in which its subject receives thorough and judicial treatment. The extent of the bibliography which it is now possible to bring together upon the subject of cancer of the pancreas has become quite large and has evidently been thoroughly studied by the authors. The condition itself is one which for its successful management must be left to curative medical treatment when the happy time shall have arrived when such treatment for cancer shall have been devised.

LEWIS S. PILCHER

## BOOK REVIEWS

TUMORS OF THE BREAST, THEIR PATHOLOGY, SYMPTOMS, DIAGNOSIS AND TREATMENT By SIR G. LLINTHAL-CHEATLE, F.R.C.S., of London and MAX CUTLER, M.D., of Chicago Philadelphia, J. B. Lippincott Company, 1931

This book, presenting 596 quarto pages and 466 illustrations, is encyclopædic in its character and may properly be claimed to present fully the present condition of knowledge as to its subject. To its composition the authors have brought the outcome of many years' study of normal and abnormal conditions of the breast, for which they have enjoyed unusual opportunities, both in extent and in character. Examination of its pages will show the critical surgeon that they embody fully the knowledge of the day with regard to the subjects treated.

Preliminary pages are devoted to the anatomy and physiology of the breast. This is followed by 100 pages devoted to benign neoplasia, after which comes, constituting the great mass of the book, the real object of its compilation—cancer, occupying more than 400 pages. The teachings of the book are based upon the premise, "Carcinoma is the presence of living, multiplying and invading epithelial cells in parts where they have no normal right to be" (Page 161).

The book essentially is one of pathology and diagnosis. The subject of surgical treatment does not enter into the scope of the book. A chapter, however, is devoted to the radiation treatment of carcinoma of the breast. The book, as a whole, in the field to which it is devoted, will secure the approval of educated and progressive surgeons, and will take an important place as a sound book of reference.

L S P

THE AMERICAN JOURNAL OF CANCER Vol. XV, No. 1, January, 1932  
Editor, FRANCIS CARTER WOOD Large 8 vo, pp. 561

WITH its number of January, 1932, the Journal of Cancer Research announces that it will be continued under the caption of THE AMERICAN JOURNAL OF CANCER, remaining the official organ of the American Association for Cancer Research and the American Society for the Control of Cancer under the continued editorship of Dr. Francis Carter Wood with the cooperation of an editorial board which includes a large number of prominent surgeons and pathologists.

The occasion for the being of this journal was a want felt by the members of the associations named of a publication devoted to the more technical side of cancer investigation, one in which articles not readily acceptable to the current clinical journals might be published. The first number of this Cancer Journal appeared in January, 1916, and has continued to the present time. It is now still to be continued as a quarterly periodical, soliciting for publication manuscripts on all phases of cancer, experimental, clinical, statistical and educational. The present number, under its new name, consti-

tutes an imposing volume of nearly six hundred large, octavo pages, about one-half of them being devoted to clinical and pathological original reports and half to abstracts of articles from current literature

That there is a place for such a journal is unquestionable. The interest in all phases of the cancer problem is universal and deep and the solution of the questions connected with it is of the highest importance. The present number of the ANNALS OF SURGERY is devoted entirely to subjects pertaining to this problem. The activities of organizations, both professional and lay, for research into its mysteries are widespread and continually increasing in importance. The cause and cure of cancer are two riddles that continually intrigue for their solution the deepest thought and the most constant and intelligent experimental research of which the human mind is capable. There is no question but what an important part in the solution of this riddle may be played by this AMERICAN JOURNAL OF CANCER, and as a collaborator in this field, we welcome it

L S P

#### EDITORIAL ADDRESS

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# ANNALS *of* SURGERY

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## A HISTORY OF THYROID SURGERY<sup>\*</sup>

BY CASPER F HEGNER, M D

OF DENVER, COLO

FROM the beginning, fatalities attendant upon injuries to the neck emphasized this region as the most vulnerable in the human body. Lesions here are conspicuous. It is only natural that these, especially enlargements of the thyroid gland, should have attracted early medical attention.

In the time of Celsus,<sup>1</sup> the thyroid gland as a normal structure was not recognized. Enlargements called *gouetie* or *heima guttuures* were considered independent new formations, either parenchymatous or cystic in character.

In communities where goitre was endemic it was considered an inoperable and frequently fatal affliction. Death was commonly the result of respiratory obstruction. Surgical relief was invoked for disfigurement, dyspnoea or dysphagia.

No other condition has attracted more attention or has been given more careful study than diseases of the thyroid gland. Little of primary importance has been discovered as to the cause, and nothing really new has been added to the therapy of goitre in the past forty years. A better understanding of the rôle played by iodine, whose beneficial effects have been known for more than a hundred years, and which has been used as a prophylactic and therapeutic remedy for nearly that long, thanks to Plummer, is now more rationally and widely used.<sup>2</sup>

Moritz Schiff, a physiologist of Geneva, in 1856, showed by experiments on dogs that total extirpation of the thyroid gland produced a sequence of ill effects which led to death. His work was overlooked for more than twenty-five years. Neither Sick, Reverdin nor Kocher made reference to Schiff when they first reported the phenomena of surgical thyroid deprivation.

Schiff, in 1884, demonstrated the symptoms of thyroid deprivation could be averted by making thyroid transplants before performing complete extirpation of the gland. He proved the thyroid gland had a secretion which is necessary to life. He paved the way for the administration of thyroid extract in the treatment of myxoedema which was introduced in 1891 by Murray and Howitz.<sup>3</sup>

Frederich Von Muller, in 1893, demonstrated an increased metabolism in exophthalmic goitre.<sup>4</sup> His work led to the study of metabolism in all forms of goitre. The basal metabolic rate has become a cardinal index of the physiological status of the thyroid gland. It is an essential diagnostic and prognostic criterion.

Eugen Bauman, in 1895,<sup>5</sup> isolated from the thyroid gland an iodine-containing compound which he called "iodothyrim." He considered this the active principle of the gland.

<sup>\*</sup> Read before the Historical Section of the Medical Society of the City and County of Denver.

Kendall, with thyroxin, made a more exact contribution to the thyroid physiology and therapy.<sup>6</sup>

Ivar Sandstrom, in 1880, discovered the parathyroid glands. He named them "glandulæ parathyreoideæ." A. Kohn, in 1895, established them (Epithel Koerperschen) anatomically, genetically and functionally distinct from the thyroid gland.<sup>7</sup>

Eugene Gley, in 1897, proved by animal experiment their physiological importance, and that their complete removal was the cause of post-operative tetany.<sup>8</sup>

The foundation of scientific surgery upon a thorough knowledge of anatomy, pathology and physiology, and their reciprocal dependence, is exemplified in the development of surgery of diseases of the thyroid gland. Surgery of the thyroid gland is a composite of contributions of the civilized world, the French, Swiss, Germans, Slavs, Italians, English and Americans playing stellar rôles.

From the dawn of medical history, on through the early centuries, there were many handicaps common to all surgery. Little anatomy and nothing of pathology, physiology or bacteriology was known. In addition, there were the purely surgical difficulties, the control of pain, of hæmorrhage and of infection. When these were mastered, surgery became a respected science rather than an inexorable art.

In certain diseased conditions of the thyroid gland the greatest and most lasting benefit was, and still is, secured by surgery. No operation has been more highly standardized and no other productive of more brilliant results than the present so-called thyroidectomy, more properly termed partial or subtotal thyroid lobectomy. The evolution of the technic of thyroid surgery has converted one of the most hazardous into one of the safest surgical procedures.

The early operations were accompanied by a frightful mortality, 41 per cent in 1850. Recent statistics show a fraction of 1 per cent. The dangers of the earlier operations were hæmorrhage, thrombosis of the jugular and subclavian veins, air emboli, injuries to the recurrent laryngeal and vagus nerves, damage to the trachea or œsophagus. The sequelæ were mediastinitis with or without abscess formation, phlegmon and fistula of the neck, erysipelas, pyæmia, tetanus, inflammation of the lung and pleura, tetany and cachexia strumipriva.<sup>8</sup> Death was due to hæmorrhage, either primary or secondary, or to the then almost inevitable sepsis.

Early surgery was imperative surgery resorted to only when the patient was *in extremis* from impending asphyxia or with a disorganized cardiovascular system. This was prior to the days of anæsthesia, before the antiseptic era, and, equally important, it was long before the development of adequate surgical instruments for the control of hæmorrhage, notably the hæmostatic forceps.

The improvement in surgical technic proceeded by stages, beginning with the introduction of general anæsthesia by J. C. Warren, October 16, 1846.<sup>9</sup> The next great advance followed Lister's epoch-making discovery of antiseptics, 1867.<sup>9</sup> Antisepsis was soon superseded by asepsis, 1870. Pasteur had

previously advocated dry sterilization of instruments and dressings<sup>9</sup> Buchner<sup>9</sup> introduced the boiling of instruments in 1878 and in 1886 Schimmelbuch,<sup>9</sup> of von Bergman's clinic, inaugurated the practice of cleansing and disinfecting the hands<sup>9</sup>

The hæmostatic forceps was developed from the prehistoric dental forceps. It first came into general use in the central European clinics in 1870 as the *Schiebevorrichtung* of Fricke<sup>10</sup>. The efficient control of hæmorrhage by means of the hæmostat replaced the crude cautery, the artery hook, the ligature carrier, the mass ligature and the crushing forceps. By these the field of surgery was vastly extended, delicate and deliberate operations became possible, elective surgery was born.

Before surgery as an elective procedure for diseases of the thyroid gland was advocated, there were a variety of methods of attacking the gland: the insertion of hair setons and canula to cause the disappearance of the tumor by suppuration,<sup>11</sup> incisions with drainage, the introduction of extracutaneous or subcutaneous mass ligatures, the application of chemical or the actual cautery, dissection, cauterization, morcellment, evident, the injection of iron, turpentine or iodine. About the middle of the nineteenth century, ligation of the thyroid arteries to induce ischemic atrophy, enucleation of nodules and cysts, transfixing ligatures with ecrasement and partial resection were recommended.

Roger Frugardi, of Salerno, 1170,<sup>12</sup> transfixed large goitres with shoe laces and permitted the ligated masses to slough.

Roger and Roland practiced the introduction of setaceum. When the goitre was adherent they encircled the mass with a shoe-lace ligature which was left firmly tied for two or three hours. The mortified mass was then cut away.<sup>13</sup>

Guy de Chauliac tunneled tumors with the actual cautery. Through the channel thus made he passed a heavy seton.<sup>14</sup>

The cure by the King's touch was practiced for over five hundred years, 1100 to 1600. Andre Dulaurens mentions that his king, Heinrichs IV, cured 1500 annually. Dulaurens, if nothing else, was an exemplary courtier.<sup>15</sup>

The first operation for goitre is credited to Albucasis, a Western Arabian of Cordova, Spain, about the year 1000. He used a crucial incision.<sup>16</sup>

Benjamin Gooch, 1770, reports two cases, both died of hæmorrhage. In one an unsuccessful attempt to control the hæmorrhage was made by digital compression exercised by relays of persons for eight days and nights.<sup>17</sup>

Adolph F. Vogel, 1771, operated on a case through a circular incision.<sup>18</sup>

The operation by Pierre Joseph Desault on May 20, 1791, is worthy of the first place in surgery of the thyroid gland if not in point of time, certainly in matter of technic.<sup>19</sup>

Jacquelin Hyon, female, aged twenty years, for seven years had trouble with her thyroid gland. In 1784, a mass formed in the right lobe, small at first then rapidly enlarged and became cystic. In 1788, it was lanced and drained of a yellowish serous fluid. The gland became adherent to the trachea.

Desault, through an anterior median longitudinal skin incision, exposed and double ligated the superficial vessels, then cut between the ligatures. The superior and then the inferior thyroid vessels were exposed, ligated and cut. The five-inch tumor was then grasped with a hook and pulled downward, mesially and laterally to mobilize the gland. It was then dissected free from the trachea, to which it was intimately adherent. For nearly sixty years this was considered an impossibility by the Swiss and German



surgeons The patient's wound suppurated but she recovered and left the hospital in thirty days Desault's case was the first in which the dissection was deliberate, the first in which the gland was dissected free from the trachea He executed the essentials of the thyroidectomy as it is understood today It was many years before Desault's technic was improved upon

Guillaume Dupuytren, January 1, 1808,<sup>20</sup> operated on a female, aged twenty-eight, who for eight years had a nodular three-lobed tumor of the thyroid gland The central lobe four inches in diameter had been removed through a transverse incision by an unnamed surgeon of Paris (This is the first mention of a transverse incision) In the following six months the lateral lobes of the tumor had grown to such a size that respiration, deglutition and the circulation became greatly embarrassed On three successive occasions the patient consulted and was examined by Dupuytren Each time he refused to operate The patient threatened suicide if no attempt was made to relieve her Dupuytren capitulated to her insistent demands for relief In Hotel Dieu on January 1, 1808, she was operated on The teguments of the anterior surface of the middle of the neck were raised in a large transverse fold, then cut perpendicularly The incision was enlarged to the symphysis of the chin above and to the sternum below The tumor was exposed, the superficial vessels were for the most part avoided, others were double ligated and cut between the ligatures The tumor was then retracted to the left and the right lobe was freed, its arteries were double ligated and cut between The left lobe was treated in like manner Then both lobes were elevated and under traction the adherent isthmus was dissected free from the trachea and removed The trachea was markedly flattened A sheaf of ligature threads was left hanging out of the inferior angle of the wound The operation was long and tedious but was practically bloodless The tumor weighed two and one-half pounds The patient died thirty-six hours later

Dupuytren called attention to the sensitiveness of arteries and recommended tying first the ligature on the side corresponding to the brain in order to avoid causing pain when tying the second or distal ligature He was the first to observe the flattening and distortion of the trachea and stated that this was due to the prolonged pressure by tumors of the thyroid gland A second time within a decade the French blazed the trail in thyroid surgery but years elapsed before that path was followed

Paul Jule Tillaux,<sup>21</sup> on May 1, 1881, reports an interesting case with exophthalmos A male, aged thirty-three, presented a marked pulsating thyroid with an audible bruit and a palpable thrill There were decided pressure symptoms on the recurrent nerve and the trachea Exophthalmos was progressively increasing The pulse was rapid and a cardiac thrill was present The patient's temper was irritable, he had nervous agitation with choreiform movements On May 18, 1881, the patient was prepared for operation, chloroform anæsthesia was just begun when patient was seized with severe dyspnoea, breathing became harsh and cyanosis extreme Operation postponed Tillaux consulted the Society of Surgeons The members were divided as to advisability of operating The patient's condition was desperate and seemed doomed if denied the chance for relief Tillaux, on May 21, 1881 with morphia and chloral analgesia under the Lister carbolic vapor spray, made a U-shaped incision Hæmorrhage was controlled with hæmostatic forceps (The first mention) The sternomastoid and hyoid muscles were cut transversely at the turn of the transverse section of the skin incision which was over the lower third of the tumor The tumor was exposed On attempting to disengage and enucleate from below the capsule was ruptured Friable debris under pressure escaped This diminished the size of the tumor, which extended downward beneath the sternum and laterally beneath the sternomastoid muscles The capsule was dissected free from the trachea above and cut away The cul-de-sac beneath the sternum was cleared of debris Wound was closed and drained through the inferior angle Lister dressing applied Operation time one and one-half hours He was placed in a specially prepared carbolized vapor room Wound healed in ten days Then erysipelas set in, he recovered from this on June 20 1881 On July 27 he died from lung metastasis Pathological

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report by Bernard —Sarcoma This case was probably an exophthalmic goitre with sarcomatous degeneration

Sir William Blizard,<sup>22</sup> of Edinburgh, in 1811, was the first to ligate the superior thyroid artery for therapeutic purpose The patient died one week later of secondary hæmorrhage and hospital gangrene

H G Jameson,<sup>23</sup> of Baltimore, May 10, 1821, ligated the left superior thyroid with animal ligature Patient cured This was the first ligation in the United States

H Earle,<sup>24</sup> in St Bartholomew Hospital, in a case of exophthalmic goitre on August 2, 1823, ligated the right superior thyroid artery and on September 11, 1823, ligated the left superior thyroid artery On January, 1824, was reported restored to health

Luiga Porta,<sup>25</sup> in 1835, ligated the thyroid arteries to induce ischemic atrophy of the thyroid gland His first two single ligations in which he tied only one superior artery were without effect In the third case both superior arteries were tied with marked, though temporary, benefit which lasted about four months Porta concluded to secure permanent benefit both superior and inferior arteries on the same side should be ligated July, 1850, through a single longitudinal incision, going between the sternomastoid and sternothyroid muscles, he exposed and ligated both arteries This was the first ligation of the inferior thyroid artery Porta proved the arteries of the opposite lobe are not capable of maintaining an adequate circulation in the lobe of the ligated side, further, ligation of the superior and inferior arteries in the same side may produce a radical effect

Patrick Heron Watson, of Edinburgh,<sup>26</sup> considered the pioneer in Great Britain in 1874, reported five successful operations for thyroid disease with the following technic which had been used in 1861 by E S Cooper, of the United States — long median incision, muscles separated, fascia of the gland exposed, superior pole mobilized with the finger A threaded aneurysm needle was then passed beneath the gland from the mesial aspect of the upper pole to the middle of the lateral aspect of the lobe This manœuvre was repeated with the remaining portions of the gland The ligatures were tied and the mass was cut away with a curved scissors This was over sixty years after the classic technic of Desault

J A W Hedenus, of Dresden,<sup>28</sup> in 1821, records six successful operations for extensive thyroid diseases This record was not excelled for nearly seventy years The success of Hedenus was a stimulus to surgery of the thyroid in Germany, but his followers for years failed to grasp the essentials of his technic Hedenus used a vertical mid-line incision, exposed the gland, ligated the superior then the inferior thyroid arteries, freed the gland, transfixed and double ligated the isthmus The mass ligation of the isthmus was practiced in Switzerland and Germany for many years following Hedenus In modified form it is still used Hedenus advised careful, gentle dissection to the posterior capsule of the gland, avoiding unnecessary and all rough handling of tissues, double ligation of the individual vessels as they are approached In substernal goitre he used a sling of heavy thread passed through the tumor to facilitate delivery from beneath the sternum

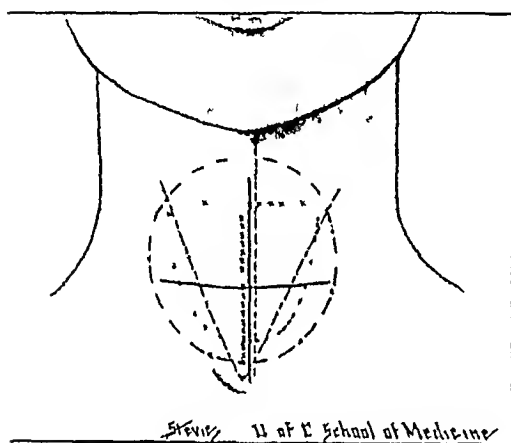
Victor Von Bruns, 1851 to 1864, had twenty-eight cases, mostly of cystic degeneration of the thyroid, however, two were carcinoma One operation required four hours to complete The instruments he used were several bistouries, dressing forceps, a scissors, one blunt aneurysm needle, one hooked and one fenestrated forceps, several hooks, ligature rods, silk and catgut ligatures, water and sponges Today, even the most resourceful operator would refrain from attacking even a simple goitre with so meagre a set-up<sup>29</sup>

Dr Charles Harris, of New York, in 1807, through a long mid-line incision, successfully extirpated a huge goitre of twenty-two years' standing by enucleating the mass piece by piece with his fingers and a knife, only two small arteries required ligation The patient was well in three weeks<sup>30</sup>

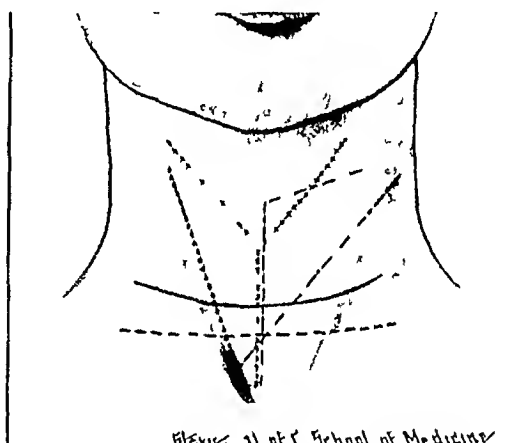
W W Greene, of Portland, Maine, is erroneously credited by some with the first radical extirpation of a goitre in the United States By 1871, he had three successful

eases<sup>31</sup> His first case was reported in 1866 Mrs K, aged forty-five, tumor right lobe of thyroid, twenty-six years' standing, had never given her trouble until a year and one-half ago Since then it had grown rapidly in size Pressure symptoms were marked, dyspnœa, dysphagia and syncope "Under ether anæsthesia a single lateral straight incision over the tumor from inferior maxilla to the clavicle was made The sternomastoid muscle which spread over the tumor like a riband together with several fasciæ was divided on a groove director going to the capsule of the tumor, which, on being raised, bled profusely The bleeding was controlled by digital pressure of an assistant The tumor was covered with a network of large, delicate-walled veins which bled fearfully With the fingers the tumor was separated, and the areolar attachments and the pedicle which contained three large arteries was reached Each was tied separately with silk When the last strand was tied the hæmorrhage ceased The internal jugular vein which had been torn was also ligated Wound was cleansed, closed by interrupted sutures Patient recovered in thirty days Weight of tumor twenty-four ounces Time of operation twenty-two minutes"

Paul Sick, in 1867,<sup>32</sup> is credited with the first total extirpation of the thyroid gland and for being the first to observe the symptoms of operative thyroid deprivation



+ Albucasis  
| Desault  
U Tillaux  
| Dupuytren  
V Rose  
T Rose  
O Vogel



\ Billroth  
— Böckel  
— Kocher  
/ } Kocher  
Y }

Jacque L Reverdin, on September 13, 1882, read a paper before the Geneva Medical Association on hitherto undescribed sequelæ of complete thyroidectomy He called the condition "myxœdema ex-extirpatione gland thyroideae" (myxœdema opératoire)<sup>33</sup> Reverdin was the first to differentiate the aponeurotic or surgical from the anatomical capsule This is an important contribution to surgery of the thyroid

Theodor Kocher,<sup>34</sup> in 1883, before the Twelfth German Surgical Congress, reported his results in 100 thyroidectomies, thirty of which developed symptoms of thyroid deprivation called by Kocher "eachemia strumii priva" He therefore counselled strongly against extirpation

It is incomprehensible that the work of Schiff done in Geneva twenty-five years before should have been unknown to these two masters of thyroid surgery

The phenomena was explained by Kocher as (1) a disturbance of the blood supply of the brain consequent to removal of the thyroid gland which at that time was supposed to exercise a controlling influence on cerebral circulation, (2) the removal of the thyroid gland altered the blood causing qualitative changes in the nutrition of the brain Several years passed before it was the acknowledged result of disturbed physiological secretion

Theodor Billroth,<sup>35</sup> April, 1861, while at Zurich (1861-1867) performed twenty

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operations for thyroid disease, eight of which died of sepsis. This experience caused him to give up the operation. In 1867, he was called to Vienna, where, with the improved management in the treatment of wounds by the method of Lister, he again took up the operation.

Billroth used a lateral incision parallel to the inner border of the sternocleidomastoid muscle. He divided the sternohyoid, omohyoid and sternothyroid muscles transversely. In 1870, the artery forceps came into general use, which greatly facilitated his technic and improved his operative results. His clinic was cursed with post-operative tetany and injuries to the recurrent laryngeal nerve. In thirty-one cases he reported 30 per cent of nerve injuries. Post-operative tetany gave rise to much discussion. Weiss,<sup>36</sup> in 1883, advanced the hypothesis that it was due to hyperæmia and irritation of the anterior horn cells of the spinal cord consequent to the ligation of the inferior thyroid arteries which increased the flow of the blood through the vertebral arteries, also, as highly probable irritation of the sympathetic nerves due to the ligation of the many vessels which stimulated the vascular centers in the cervical spinal cord and medulla. Billroth dissented from these opinions and suggested that it was due to the division of numerous nerves supplying the thyroid gland. The latter work of Sandstrom and Gley proved for all time the anatomical and physiological importance of the parathyroid glands.

Important as was Billroth's work in thyroid surgery<sup>37</sup> (in the early 'eighties he did more than any other surgeon), his chief influence was the interest he aroused in, and the stimulus he gave to, that galaxy of very able assistants, who later became famous surgeons. Wolflei, von Mikulicz, von Eiselsberg, von Haberer, Kocher. Each made valuable contributions not only to surgery of the thyroid gland, but also to other fields of surgery, notably that of the gastro-intestinal tract. The justifiable pride of the illustrious master was excelled only by the undying loyalty of his renowned assistants.

Anton Wolfier first called attention to the danger of injuring the recurrent nerve when ligating the inferior thyroid artery. He revived the practice of ligating the thyroid arteries as a preliminary to the more radical operation. Ligation was previously performed to induce ischæmic atrophy in the gland. This procedure was found to be contra-indicated in cystic, colloid, degenerated and calcareous types of goitre. It did produce striking improvement in the hyperplastic and pulsating vascular enlargements.

Von Eiselsberg, in 1892, was among the first to experiment with parathyroid transplants.<sup>38</sup>

Johann von Mikulicz Radecki<sup>39</sup> rigidly followed the teaching of his master, Billroth. He noted the frequent sequelæ of recurrent nerve injury, of tetany and cachexia strumipriva. These were not understood at that time, but attributed largely to rough handling of the tissues and injury to the thyroid nerves. Compression of the trachea, when present, not only persisted but occasionally increased after removal of the lobe in the unilateral operations. To relieve this embarrassing situation, removal of the opposite lobe became necessary at the first or at a subsequent operation. Radical excision, described by Reverdin and Kocher as the cause of thyroid deprivation, was fully appreciated by Mikulicz as an operation to be avoided and justified only in cases of malignant disease of the thyroid. To obviate these unpleasant complications, Mikulicz devised his operation of bilateral resection, the so-called *melon schnitt lobectomy*, leaving only that portion of each lobe which is in relation with the posterior capsule and the inferior thyroid artery.

Mikulicz mobilized both lobes, ligated both superior thyroid arteries and the superficial branches of the inferior thyroid arteries, freed the anterior and lateral surfaces of the trachea, avoided dissecting too far posteriorly for fear of injuring the recurrent nerve. He then split the lobe longitudinally, removed the melon-shaped section, leaving only that portion of the gland and its capsule in the groove between the trachea and

œsophagus This bilateral partial resection marked a decided advance in technic It eliminated the complications which were hitherto common With unessential modification it has been adopted wherever thyroid surgery is done Commenting on his experience with the bilateral resection method he said "I have had no complications and the convalescence was smooth Whatever the function of the thyroid gland, be it a regulator of cerebral circulation, a blood-building organ, a gland with an essential secretion with important sympathetic nerve connection, the bilateral resection leaves a portion to continue to supply those functions Damage incident to extirpation to the posterior living structures, especially the recurrent laryngeal nerve, is most surely avoided" Had the role of parathyroid been known at this time he might have added these structures are preserved

A Lucke,<sup>40</sup> of Berne, the predecessor of Kocher, was the authority on goitre before 1870 He advocated and practiced the parenchymatous injection of iodine This procedure was attended with alarming and occasionally fatal consequences iodism, paralysis of the recurrent laryngeal nerve, sudden death from embolism and thrombosis, œdema and closure of the glottis<sup>41</sup> For a time he opposed ligation of the thyroid arteries and excision except for freely movable or pedunculated tumors He revised his opinion for in 1872 he published a report of ten cases, mostly of adenomata, with only one death

C Bockel, of Strasburg,<sup>42</sup> reported a case of sarcoma of the thyroid in which he performed a thyroidectomy using a transverse or single flap incision In order to secure greater exposure he dissected the flap upward Mention of transverse incision has been made before, but Bockel's was the first report describing it The transverse incision was a long time coming into general use Credit is usually given to Kocher While he popularized it he did not use it until some years after Bockel's report

August Socin,<sup>43</sup> of Basel, practiced the intraglandular enucleation of adenoma, a modification of the procedure of Porta This operation was a blunt or finger dissection of the adenoma from within the gland It was a rough and incomplete operation Primary and secondary hæmorrhage and infection were more common than with the cutting operation of excision<sup>44</sup> Kocher was opposed to this technic because it was not usually complete, the capsule was rarely seen and the many remaining nodules took on rapid growth

Theodor Kocher,<sup>45</sup> a pupil of Langebeck and Billroth, in 1872, at the age of thirty-one, succeeded Lucke at Berne He was conversant with and stimulated by the operative success of his predecessor Kocher was a born student and keen observer He accepted only those new ideas which after personal trial had proven their merit He was among the first Continental surgeons to adopt the principles of Lister and did much to popularize the method He was foremost in simplifying the process and in developing the aseptic technic

Kocher studied the anatomy, especially the circulation of the thyroid, and demonstrated by the injection of colored fluids the vascular distribution to the gland and within the larynx and trachea This established the reason for the catarrhal inflammation and œdema of the trachea which frequently follows thyroidectomy

In his first two years as chief of the surgical clinic at Berne he performed thirteen thyroid operations He said "There are three types of operations for thyroid disease (1) total extirpation, (2) partial thyroidectomy or resection, (3) enucleation"

He was then using the median and the oblique lateral incisions of Billroth whose technic he closely followed He removed the gland piece by

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piece and with cysts sutured the capsule to the skin, leaving the wounds open. August 1, 1874, he did his first total extirpation on a girl, aged eleven. A few weeks after the operation she developed marked change in character, became dull, sluggish and sullen. He stated "It is a question whether there is a connection between mental deterioration and extirpation of the thyroid gland." Reverdin's report, in 1882, on two cases with "myxœdema ex-extirpatione gland thyræoideæ" prompted Kocher to reexamine all of his operated goitre cases, 101 in number. Seventy-seven were alive, seventeen did not report. Of the sixty remaining, five had carcinoma of the thyroid, two died of unrelated intercurrent illness, nineteen reported by mail. Those with unilateral excision were for the most part enjoying good health. The thirty-four total resections examined personally were less favorable. "One had tetany, sixteen showed varying grades of progressive mental and physical deterioration and changed physiognomy (old facies). They were sensitive to cold, anæmic, sluggish of speech and movement, showed general œdema and had peculiar skin changes and falling hair." He compared this condition to cretenismus and called the syndrome "cachexia strumipriva." This experience caused Kocher to take a decided stand against extirpation and it was years before he performed bilateral resection.

This first example of follow-up study was illuminating not only to Kocher but to the entire medical world. The importance of critical follow-up studies should be emphasized in every hospital and clinic as one of its most valuable educational functions. The value of follow-up studies is a vital contribution to the medical and surgical profession scarcely second to Kocher's outstanding work in goitre.

Following the suggestion of Kocher, between 1880 and 1890 the school children of the canton of Berne were examined. Kocher urged the Swiss Government to boil the drinking water and to add iodine as a goitre-preventive measure. McCarrison years later in the Punjab confirmed Kocher's stand. More recently in the United States similar studies and recommendations were carried out by the Marine.<sup>46</sup>

In 1877, Kocher substituted fine silk for catgut. In 1878, he changed from the straight median to the oblique, and, in 1882, to the winkel or angulated incision. If circumstances demanded, he made it a Y-shape by adding another arm. He dissected the gland from the trachea which ten years before he considered difficult.

In 1890, he discarded all other incisions for the transverse or collar incision made in one of the natural folds of the skin. About the same time he gave up the use of antiseptics in his operation wounds, having used solutions of carbolic acid, zinc chloride, bismuth, bichloride of mercury and adopted the more simple aseptic technic. He also shifted from the extra-capsular to the intracapsular attack on the gland, performing what he called an enucleation resection, leaving the healthy gland tissue in relation with the posterior capsule to avoid injury to the recurrent nerve.

Kocher, deliberate, deft and gentle, made precise anatomical dissection in every case. He cut the strap muscles, exposed the gland, double ligated the superior thyroid artery, placing a third ligature on the superior pole before delivering the lobe which was drawn upward, then, after clearly visualizing the inferior thyroid artery, ligated it at a point where it changes its course from the horizontal to the vertical, just mesial to the carotid artery.

His operations on intrathoracic goitre are important. He recognized pressure of the goitre as the cause of softening of the cartilages, distortion of the trachea and the consequent respiratory embarrassment.

Dupuytren, who first called attention to the distortion and softening of the trachea, thought the diminution of oxygen was the cause of the goitre. Tracheotomy was occasionally performed as a precaution against asphyxia. The necessity for this can be appreciated since long standing and very large adenoma were quite common.

Billroth's clinic was troubled with tetany and injury or paralysis of the recurrent laryngeal nerve but had few recurrences of the goitre. Kocher, on the other hand, rarely saw tetany, had few recurrent nerve injuries but did have recurrences of the goitre.

In 1917, before the Swiss Surgical Congress, he reviewed his entire surgical experience in thyroid diseases, reporting 2 per cent mortality in ordinary and 2 per cent in exophthalmic goitre.

Kocher is deservedly acknowledged the leading authority on surgery of the thyroid gland.

W. S. Halsted, than whom no man in the United States did more to stimulate interest in thyroid diseases or more to develop a standardized technic, began his studies in 1879, while he was in Vienna, with his work on the development of the thyroid in fish. In 1887, he began his experiments with thyroid transplants in dogs.<sup>47</sup> This work resulted in the discovery of histological changes typical of hyperplasia and a correct histological interpretation of exophthalmic goitre. He was the first to administer iodine to prevent post-operative or recurrent hyperplasia. In 1909, his work on the parathyroids and their relation to tetany is unsurpassed. He found that parathyroid homographs would not live unless a considerable deficiency was created and proved, the life of a dog could be maintained by a section of parathyroid one-fourth of a millimetre in diameter, which, if removed, would cause the animal to die of tetany.

Halsted's refined technic of thyroidectomy, developed in conjunction with W. G. MacCallum is founded on precise anatomical and physiological principles. In this respect he ranks next to, if not equal to, Kocher. Halsted, in 1879 popularized the use of the hæmostatic forceps in the United States. In 1884 he was among the first to use transfusion of defibrinated blood. In 1885 he became the pioneer in local infiltration and conduction anaesthesia which greatly improved mortality statistics in thyroid surgery.<sup>48</sup> In 1881,

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he introduced the rubber tissue drain and in 1890 rubber gloves replacing the cotton gloves recommended by Mikulicz<sup>49</sup>

C H Mayo has had more experience in thyroid surgery than any other man in the world Reports from The Mayo Clinic have been an important factor in disseminating an understanding of the surgical technic and operative difficulties, which, in turn, greatly improved thyroid surgery

The work of Crile, in Cleveland, Lahey, in Boston, and Bartlett, in St Louis, is also a prominent factor in making thyroid surgery safe and in developing a type of operation in the United States which is quite different from that performed elsewhere

The variety, length and direction of skin incisions used in the operations for goitre were many, before the simple transverse or collar incision became the incision of choice The incisions are illustrated in the drawing shown in Figs I and II and collectively resemble a spider web

One is forcibly reminded of the criticism of Edm Rose, who used a V- or T-shaped incision<sup>50</sup> when he stated the older operations for goitre in which the thyroid was attacked like an ordinary tumor, reminded him of working as in a spider web, ligating and repeatedly re-ligating the same vessels until the margins of the tumor were reached, where the large parent veins were torn and massive hæmorrhage occurred, obscuring the field Blind mass ligatures applied to control this hæmorrhage caused frequent damage to the important structures<sup>51</sup>

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## THYROIDITIS\*

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FROM THE LAHEY CLINIC

Clinical and pathological studies of goitre patients have demonstrated that thyroiditis is a relatively frequent finding. The significance, therefore, of inflammatory processes in the thyroid and their relation to goitre formation, to the occurrence of hyperthyroidism and to the late appearance of myxoedema can not be overlooked. We have divided this condition into I, Simple thyroiditis, *A*, Primary in the thyroid, *B*, Secondary to generalized infection; II, Suppurative thyroiditis, *A*, Primary in the thyroid, *B*, Secondary to generalized infection; III, Chronic thyroiditis (including Riedel's struma), *A*, Primary in the thyroid, *B*, Secondary to general infection.

*Simple thyroiditis*, primary in the thyroid, is not uncommon. We have reviewed the records of forty-two recent cases seen in the past five years, and we have the distinct impression that there have been many other patients whom we have examined and considered as early colloid goitres who might well have fallen into this classification of simple thyroiditis. It has been our experience that simple thyroiditis is not a serious disease, either in its course or in its outcome. Over 50 per cent of our cases have very clearly been associated with a preceding infection of the tonsils, the pharynx, the teeth or the upper respiratory tract.

The typical patient presenting simple thyroiditis will give a definite story of repeated attacks of tonsillitis or of a recent sore throat or laryngitis or an infected tooth. Usually this infection has begun to quiet down when tenderness and swelling are noted in the region of the thyroid gland. Very commonly an early symptom is pain on swallowing solid food. The tenderness may start on the left or right side of the thyroid and gradually spread to the opposite lobe, disappearing on one side as the process extends to the other side of the gland. Very rarely have we seen any evidence of difficulty in breathing in these cases. A low fever ranging from 99° to 100° F. is occasionally present in the early stages of simple thyroiditis. Rarely it may be more severe and may persist for many days.

Mild symptoms of hyperthyroidism are occasionally present. Thus in two of our cases definite toxic symptoms of mild degree were present and disappeared as the process improved.

On examination, the thyroid gland is generally found symmetrically enlarged, but only to a very moderate degree. It is slightly firm and gener-

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Portion of this paper read by Doctor Clute at the American Association for the Study of Goitre, Kansas City, Missouri, April 9, 1931.

ally definitely tender. It is not adherent to the muscles. There is no pulsation of the vessels. In these early cases the basal metabolism is usually within normal limits. Rarely, however, it may be elevated to  $+15$  or at most  $+30$ . It returns to normal, as a rule, as the process recedes.

The tenderness in the thyroid gland persists for eight to ten days and then gradually disappears and the entire disease runs a course of twelve to eighteen days. Any clinical evidence of slight toxicity which may be present disappears within two to three weeks. Rarely a recurrence of the process may arise. This occurred in one of our patients who had a simple thyroiditis which subsided and a month after recurred and went on to the formation of multiple abscesses.

Since the process of simple thyroiditis is a mild and relatively benign process, it is not remarkable that myxœdema following in later years is relatively rare. In our records only one patient has developed a later myxœdema following a history of simple thyroiditis with no operation having been performed.

The treatment of simple thyroiditis consists in putting the patient at rest for a few days during the acute stage, the application of an ice collar to the neck and the administration of codeine and aspirin for pain. Careful observation of the course of the disease in order that the possible need of surgical drainage of an abscess may be determined early in the course of the disease is important. It has been stated that in simple thyroiditis the administration of Lugol's solution is of value. It is presumed that in the presence of an inflammatory process in the thyroid there will be an accompanying hyperplasia which in turn may well account for the onset of mild toxic symptoms. Lugol's solution may be given to produce involution of this hyperplastic area and hasten the process of repair in the gland.

Suppurative thyroiditis, primary in the thyroid gland, is, in our experience, a much more unusual condition than simple thyroiditis. We have seen five cases of either discrete or multiple abscess of the thyroid gland in the clinic. The onset of suppurative thyroiditis is marked by symptoms of a clearly serious nature. Preceding the onset there had been a history of infection in the throat or upper respiratory tract in four cases. Infection of the thyroid appeared with chills, fever, and local tenderness. Not infrequently the fever rises to  $102^{\circ}$  or even  $103^{\circ}$  F. Repeated chills are not common, but may occur. Difficulty in swallowing is an early symptom, and the patient may find that bending the chin toward the chest makes swallowing markedly easier, since this position relaxes the pressure of the prethyroid muscles on the gland.

The thyroid gland is definitely palpable and moderately enlarged. It is extremely tender and is noticeably more tender than in simple thyroiditis. There is a distinct tendency for the process to arise in one lobe or even the upper portion or lower portion of one lobe, and for this part of the gland to be adherent to the overlying structures. Palpation, however, is very difficult.

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because it causes severe pain. Mild symptoms of hyperthyroidism may well arise in association with suppurative thyroiditis and were present in two of our cases.

The course of the disease is at times marked by the development of more serious difficulties. Loss of weight may be rapid and severe, due to the infection and to the difficulty which the patient has in swallowing sufficient food. Fever continues and in one of our cases persisted for two weeks before active surgical measures were permitted, the temperature rising to  $102^{\circ}$  and  $101^{\circ}$  F. each day and going below normal each morning. The patients appear septic with a peculiar pale yellow tinge to the skin. The abscess, if unrecognized and untreated, may rupture on to the surface of the neck or into some neighboring viscus, such as the œsophagus, trachea or mediastinum. Such an accident usually results fatally. Œdema of the larynx with suffocation or with less severe respiratory difficulty may occur. Bronchial pneumonia may also arise in association with the infection.

Suppurative lesions in the thyroid gland occur not infrequently in association with generalized infection. Thus we have seen one abscess in the thyroid in a patient with a septicæmia with hæmolytic streptococcus blood cultures. Abscesses of the thyroid have been repeatedly reported as occurring in the course of typhoid fever, pneumonia, puerperal infection, *etc*.

The detection of suppurative thyroiditis in the course of a generalized infection is usually possible by simple observation and examination. In septicæmia, however, the abscess may develop insidiously and reach a considerable size without giving any active symptoms. This was our experience in one case.

The treatment of suppurative thyroiditis is of course drainage. A free incision in the neck should be made, the skin flap lifted as in the usual thyroidectomy, the prethyroid muscles retracted and cut, if need be, over the site of the inflammatory process and the lesion dealt with under direct vision. In this manner a lobe showing multiple abscesses may be resected, a large abscess may be adequately drained or an infected adenoma can be completely removed. Furthermore, the adequate drainage so essential in these cases can be more certainly established if adequate exposure is obtained.

The outlook for recovery in suppurative thyroiditis, when it is a primary lesion in the thyroid, is good. When, however, the abscess is secondary to a generalized infection, the outlook is of course serious. After drainage of the primary infection, recovery is rapid and the process has been checked in every case that we have seen. Delayed operation, inadequate exposure, and incomplete operation, however, may well permit the process to continue and a serious or even fatal result to follow.

Under the heading of chronic thyroiditis we may group many patients. Thus, we have been able to collect from our records forty-three patients with chronic thyroiditis, twenty-two cases of Riedel's struma, fifteen cases of thyroiditis with associated hyperplasia, two cases of tubercular thyroiditis and

two cases of syphilitic thyroiditis, a total of eighty-four cases of chronic thyroiditis, either primary or secondary in origin

The etiological factors involved in the production of chronic thyroiditis are not as clear as those preceding the onset of simple and suppurative thyroiditis. In a very definite group of patients, however, preceding infection in the tonsils, teeth and throat seem to bear a definite relationship to the later occurrence of chronic inflammation of the thyroid gland. In certain cases it would seem from the history that a preceding acute thyroiditis had been present which subsided spontaneously, leaving a chronic inflammatory process in the gland. It is logical to assume that chronic thyroiditis is but the late stage of an infection in the thyroid which has not subsided, but has gone on to the production of increasing amounts of connective tissue and in the late stages (Riedel's struma) nearly an entire loss of all secretory structures in the thyroid gland. Under the stimulation of an inflammatory process in the thyroid gland, hyperplasia of certain thyroid follicles results. We have in our series seen fifteen cases of marked thyroiditis with definite hyperplasia of the surrounding tissue. Of these fifteen patients, twelve were diagnosed clinically as primary hyperthyroidism or adenomatous goitre with hyperthyroidism. They showed high basal metabolism rates and clinically were thyrotoxic. All fifteen cases were operated upon, a subtotal thyroidectomy being done in fourteen and a hæmithyroidectomy in only one, and all made a good clinical recovery from the operation. In the follow-up of these cases, however, it is to be noted that, with two exceptions, in which the basal rates were  $+11$  and  $+9$ , all the rates were below normal, varying from  $-6$  to  $-36$ . In five patients of this group, all of whom had subtotal thyroidectomies, myxœdema developed post-operatively.

From our experience with this group of patients, we are impressed with the fact that definite symptoms of hyperthyroidism may and do arise in patients whose thyroid gland shows histologically marked thyroiditis with hyperplasia.

In reviewing the forty-three patients with chronic thyroiditis, of whom all but one were operated upon, we are impressed, first, with the difficulties which this group have presented in clinical diagnosis, and, secondly, with the frequency with which myxœdema follows operation. Thus, in these forty-three cases, twenty-one were diagnosed as single or multiple adenomata before operation and twelve had the same diagnosis at operation. Three were diagnosed as malignant clinically and four were diagnosed as possibly malignant at operation. Of the group, twelve were diagnosed as thyroiditis clinically and twenty-four were diagnosed as chronic thyroiditis at the time of operation.

Myxœdema developed in fifteen of the forty-three patients with chronic thyroiditis. In one of these patients no operation had been performed. In one, a biopsy only was performed, in five patients, either a hæmithyroidectomy or excision of an adenoma was done, and in the remaining six cases a subtotal thyroidectomy was performed. Such an incidence of myxœdema in this group of patients with chronic thyroiditis makes it apparent that when

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the condition can be recognized, an operative procedure should be employed which will relieve the symptoms of which the patient complains, establish definitely the presence or absence of malignancy, and leave as much thyroid tissue—poor though it may be—as is possible, for the future maintenance of thyroid function to protect the patient against possible myxœdema.

In 1926, Smith and Clute reported five cases of Riedel's struma from this clinic. The subsequent history of these five patients shows that two developed definite myxœdema, two are apparently well, and one died with malignancy in the thyroid gland. The microscopical sections from this patient, who later developed malignancy, were reviewed by many pathologists and opinions were about equally divided as to its being Riedel's struma or malignancy. The final outcome of the patient demonstrates that the true diagnosis was malignancy and shows the great difficulty which pathologists have in separating marked Riedel's struma from malignancy.

Since 1926 there have been seventeen additional cases of Riedel's struma in the clinic, making a total of twenty-one cases which we may report at this time. In these twenty-one cases, seven, or one-third, developed myxœdema after operation. One died at home of pericarditis, and thirteen are now known to be well. It is of interest to note, however, that the basal metabolic rates taken a year or more after operation in nine of these thirteen patients are all low, although they have no clinical myxœdema. Their rates are from  $-3$ , the highest, to  $-25$ , the lowest.

In Riedel's struma, which is histologically a thyroiditis of most extreme degree, with almost complete replacement of thyroid tissue by round-cell infiltration, myxœdema develops much more frequently than in chronic thyroiditis of lesser degree. It is significant that by basal metabolic examination and clinical findings myxœdema developed in seven of the twenty-one cases, and in nine of the cases definite low rates were present, though no actual myxœdema occurred. These findings make it most important that in patients with Riedel's struma as much thyroid tissue shall be left as is possible after relieving the patient's symptoms of constriction of the trachea.

We have had in our experience two cases of syphilitic thyroiditis. The first was a case of diffuse thyroiditis, clinically a chronic thyroiditis which was associated with a very marked narrowing of the larynx and upper trachea, and was accompanied by and probably arose from a mild laryngitis. The second case of syphilitic thyroiditis was apparently gummatous with a large adenoma-like swelling of the isthmus. A very marked syphilitic tonsillitis and pharyngitis and a positive Wassermann were present. Both did well with antispecific treatment.

There have been two cases of tubercular thyroiditis found on histological examination of operative specimens. Each case occurred in women, one of forty-five, and one of forty-seven, who on clinical examination presented apparently an adenoma of the thyroid. There were no toxic symptoms in either case. The adenoma was excised and each patient recovered with no

further difficulty No myxœdema developed No extensive conclusion can be drawn from these two cases

The onset of chronic thyroiditis is slow and the time of its first appearance is generally not readily placed In certain cases the hard, firm swelling in the neck is discovered accidentally by patient or physician In other cases, the patient complains particularly of an uncomfortable feeling in the region of the thyroid gland, with some difficulty in swallowing In the more severe types of chronic thyroiditis, particularly in Riedel's struma, dysphagia is the leading symptom Tenderness over the gland is frequently present but is not outstandingly severe In certain cases there is a low grade fever, with a temperature ranging from 99° to 100° F and persisting for many days

On examination, the thyroid gland in patients who had no previous goitre is symmetrically enlarged, very firm and hard It is rare for it to be markedly adherent to the overlying structures, however, and the freedom of mobility of the entire thyroid in these cases is one of the few diagnostic points which distinguishes thyroiditis from malignancy

The treatment of chronic thyroiditis is determined primarily by three factors first, the necessity of arriving at a positive diagnosis as to the presence or absence of malignancy in many cases, secondly, the need of removing sufficient thyroid tissue to overcome the pain and pressure symptoms, and, thirdly, the need of operation to cure the hyperthyroidism which is occasionally present

In patients who have symptoms of hyperthyroidism, but present a normal or low basal metabolic rate, operation should be delayed until the symptoms are more intense and the basal metabolism definitely elevated In patients in whom the thyroiditis causes marked dysphagia, excision of the isthmus alone will tend to prevent the high incidence of post-operative myxœdema

#### CONCLUSIONS

Acute thyroiditis rarely occurs as a serious prostrating condition It occasionally progresses to abscess formation and requires adequate exposure and adequate drainage

Syphilitic thyroiditis occurs as a diffuse thyroiditis or as a nodular gummatous thyroiditis It is cured by antispecific treatment

Tubercular thyroiditis is found occasionally on microscopical examination of thyroid tissue It has little clinical importance

Chronic thyroiditis frequently produces considerable constriction of the trachea with pressure symptoms and requires surgical relief

An operation such as we have suggested (removal of the isthmus) relieves the constriction and does not produce myxœdema

Myxœdema is particularly apt to follow operations on the thyroid for thyroiditis

## NODULAR GOITRE

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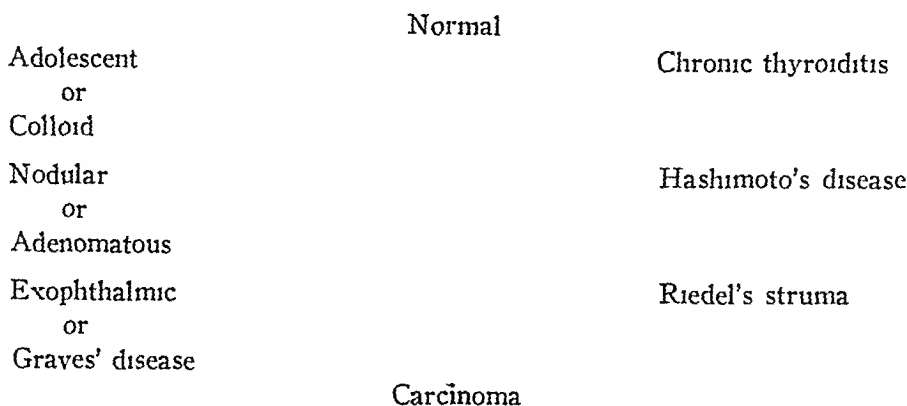
FROM THE THYROID CLINIC OF THE NEW YORK POST-GRADUATE HOSPITAL

THE term "nodular goitre" is gradually displacing "adenomatous goitre" and has a more significant meaning, as the latter is very misleading due to the fact it indicates a true pathological process, while the former refers only to the form and not to histo-pathology

It is essential to understand that the different stages of goitre transformation do not represent distinct disease entities, as was formerly taught, and to accept the teaching that we are dealing with stages of a continuous process, as anyone who has studied the clinical and histo-pathological picture of the disease realizes that the different stages cannot be made to coincide clinically and pathologically

The normal histological picture of different ages from stillbirth to senility have been studied<sup>2</sup> but the findings do not present a constant picture for people of a relative age. After a study of sections from the six groups, namely, stillbirths, infants, children from two to twelve years, adolescents from twelve to eighteen, adults from eighteen to sixty, and the senile group from sixty to ninety, in none of which was there a relatively constant picture except the stillbirths—from the study of these sections one cannot prognosticate the age of the individual from histological findings

We are well aware of the classification which is generally given for goitres, but it is difficult for one to conceive of so many different diseases arising in one organ as have been described for the thyroid gland, particularly when the normal histology of the gland is so little understood. Therefore, for practical purposes, it would seem better to consider the cycle of thyroid diseases running according to the following diagram, which takes into account the different clinical pictures with the histo-pathology



It is apparent to those who are constantly examining patients with thyroid disease that we are dealing with a transitional process and it is difficult with



normal metabolic readings and a gland that is slightly palpable to state whether the enlargement is physiological or pathological, and whether treatment should be instituted or not

Womack and Cole,<sup>6</sup> in a very recent publication, state "Apparently the amount of change produced in the gland depends on the strength of the stimulus and the time it is at work and the amount of colloid or iodine that is present in the thyroid or that is easily available. Intense changes in the thyroid gland occurring during an infection can be almost completely prevented by feeding the animal large doses of iodine. Likewise, we have found it more difficult to produce glandular changes in the summer, when the thyroid is in a more complete resting phase and thus contains iodine. Since it is possible to produce hyperplastic changes in the thyroid gland experimentally, and since it is likewise possible to cause an artificial involution by the use of iodine or a natural involution by the withdrawal of the stimulus, it occurred to us that it would be of value to study the anatomical changes that occur in the gland by a repetition of the cycle."

They used dogs for their experiments and in their summary state "Following involution brought about by the disappearance of the stimulus causing the increase in function or by artificial involution due to the administration of iodine, replacement of fibrous tissue occurs. Repetition of this physiological cycle may produce a nodular goitre similar to the so-called adenoma. The occurrence and location of these nodules is apparently dependent on the amount and the location of the fibrosis."

Keilty,<sup>4</sup> in a paper on the inflammatory nature of nodular goitre, states "The purpose of this paper is to present the conception that many of the nodular thyroid glands should be considered as being inflammatory rather than as tumors. This is a part of a critical study of one thousand thyroid glands over a period of eight years. These cases represent the routine hospital admissions in central Pennsylvania. The cases include all forms of thyroid disease with the nodular types making up more than one-fourth of the group. The clinical picture of chronic thyroiditis varies. The gland is always enlarged above normal, usually uniformly. Some parts are frequently more involved than others and in the sub-sternal type most of the enlargement may be below the sternum. The gland is predominantly nodular, the resistance is increased over that of simple hypertrophy. In the cystic types fluctuation may be apparent and in the smaller contractive forms the denseness of the calcareous and bony changes may increase the resistance. Following the combined study of histories, gross specimens, and microscopical slides over a period of ten years, the opinion is expressed that a large proportion of the nodular thyroid glands, toxic and non-toxic, show the pathological evidence of chronic productive and contractive thyroiditis rather than adenoma." I have reported cases<sup>3</sup> to substantiate clinically what these authors have found true experimentally and pathologically.

The advice to a patient with a nodular goitre becomes clearer as its pathological picture is unfolded. The first step in an enlarged thyroid, whether it

## NODULAR GOITRE

is physiological or pathological, is the storage of colloid in the acini, the one exception to this has been the exophthalmic goitre, but it would seem that even in this type of goitre there is a colloid stage which may not have been detected by the patient, or the family physician, as it is well known that patients who are acutely ill from exophthalmic goitre may have no palpable gland and the size of the thyroid is no indication of its toxicity. So it would seem, because the gland in the exophthalmic type has not been noticed enlarged by the patient until the classical onset of symptoms, that there has not been a colloid formation preceding the date of history.

In some clinics it is taught that the adolescent type spontaneously involutes to normal in most patients without medication, also, that the colloid type that seeks treatment after several years' duration cannot be cured by iodine or thyroid medication, and this is due in many instances to the presence of an associated chronic thyroiditis with increase in interacinar connective tissue, but these cases are frequently benefited by treatment due to the absorption of the colloid from the distended acini.

The explanation of nodular goitre in most instances is due to the colloid stage involuting to normal in the major portion of the gland but leaving an area, or areas, of colloid encapsulated in connective tissue which is not detected on physical examination. But, when excessive demand is made upon the thyroid during the child-bearing period, the encapsulated colloid, not being able to meet the normal demand made on it, as the rest of the gland does, immediately enlarges, due to excessive secretion of colloid, and soon a nodular area is palpated in the gland. True adenomata of the thyroid arising from Wolfert rests do exist but they do not constitute over 10 per cent of the nodular group.

The teaching has been that nodular or adenomatous goitres are not amenable to medical treatment and that harm is usually done if iodine or thyroid medication is given to this type, but cases have been reported<sup>3</sup> to show that this is not altogether correct. In most instances the nodular goitre does not respond to medical treatment, but, if the basal metabolism is normal and the nodules have been present only for a few months, there is no particular harm in treating this type of case with thyroid extract or iodine, providing the patient is kept under constant observation. After six or eight months, if no improvement has been noticed, then treatment should be discontinued, as no benefit will then be noted and the sooner the patient submits to surgery the better, as between 2 to 3 per cent of the nodular group take on carcinomatous changes.

*Comment*—We are indebted to Hertzler<sup>1</sup> more than any other individual for a clearer clinical and pathological picture of thyroid diseases, as he has had the opportunity to study the clinical cycle of the disease, and correlate the pathological process with the clinical picture which has given us a true conception of thyroid pathology. Rienhoff<sup>5</sup> more recently stressed the involutional phases of goitre pathology and it should be remembered that there are very few diseases that belong exclusively to surgery, but numerous

authors in the past have tried to make one believe that there is no place for medical treatment in the nodular or adenomatous goitre and it is exclusively a surgical problem. But if one selects the smaller goitres of recent origin it will be gratifying to see definite improvement in some, and actual disappearance of nodules in others. In cases that medical treatment will benefit, improvement should be noticed in the individual within six to eight months.

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# LINGUAL THYROID

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FROM THE THYROID SERVICE OF THE UNIVERSITY OF PENNSYLVANIA HOSPITAL

EMBRYOLOGISTS are practically all agreed that the thyroid gland arises from the fourth branchial pouch, as a median ventral invagination of the entoderm of the pharynx. This invagination is marked in later life by the foramen cæcum. The invagination is dragged down with the trachea, and, like the trachea, divides into the two lobes usually found.

The parathyroid glands have an anlage separated from that of the thyroid arising as paired structures from the entoderm of the third and fourth branchial clefts. Although they early attain positions adjacent to the thyroid, the parathyroids descend independently of the thyroid, which fact is consoling in the consideration of aberrant thyroid glands.

Developmental abnormalities of the thyroid are relatively uncommon. The migration caudalward, of the thyroglossal tract, may be arrested at any one of several positions in the line of its descent, such as (1) Lingual, (2) sublingual, (3) suprahyoid, (4) infrahyoid, (5) aberrant lateral, and (6) normal. Other faulty positions after complete descent, such as retrotracheal and intrathoracic, are not uncommon.

It is the purpose of this paper to consider only lingual thyroid with a suggestion as to the management of the condition.

A review of the literature makes one agree with Cattell<sup>1</sup> who says that "The least frequent of all aberrant locations of the thyroid is the lingual." He found that only two cases had been encountered in 7,600 operations on the thyroid at the Lahey Clinic. I find records of only two cases of lingual thyroid among over 4,000 patients with thyroid disease seen at the University of Pennsylvania Hospital. In 1925, Ashhurst<sup>2</sup> reported the only case of carcinoma of a lingual thyroid which I can find. In all, there are approximately one hundred cases in the literature. The relative infrequency of the condition is at once apparent. The follow-up reports on patients who have had lingual thyroidectomy are distressing. Post-operative myxœdema of varying degrees has been the rule. Lahey<sup>3</sup> feels that the development of post-operative myxœdema in these cases depends upon whether or not there is more thyroid tissue present. He reported a case of his own in a girl twenty-five years old, who developed myxœdema post-operatively. Hartley<sup>4</sup> concluded after his experience with a case which developed marked myxœdema after operation that the surgeon should interfere only when marked symptoms arise and only a minimum amount of tissue should be removed when a normally situated gland cannot be felt. He says "It is important to decide whether the tumor is a true ectopia of the thyroid or merely an accessory

thyroid The absence of a palpable isthmus favors the diagnosis of true ectopia "

The discovery of a lingual thyroid does not necessarily indicate active treatment It might reasonably be expected to make the same response to physiological demands that a normally situated gland does, namely, enlarging somewhat in adolescence, fluctuating in size with the menstrual cycle, possibly increasing in size during an acute general infection and pregnancy Rubel<sup>5</sup> has reported an interesting case of a woman who was cognizant of a lingual thyroid first at puberty It fluctuated in size with menstruation and attained such size during a pregnancy that tracheotomy seemed imperative After Caesarian section at term the goitre subsided to its former size and required no further treatment

Smyth<sup>6</sup> found that the majority of reported cases occurred between the ages of fifteen and forty-five years, and felt that this was explainable by the fact that during this age period the thyroid attains its highest point of functional activity I agree with Fetterolf,<sup>7</sup> however, that the majority of our patients are subjected to more careful examination during this period and that when lingual thyroid is present, it has been there since birth

*Treatment*—When a lingual thyroid attains such size as to produce urgent dyspnoea and dysphagia at any age, active treatment is indicated In the young, tracheotomy should be the first step In the mature patient it may or may not be necessary before thyroidectomy depending upon the dexterity of the surgeon and the degree of dyspnoea When doing tracheotomy in the young patient, a large enough incision should be made to allow for an exploration of the neck to determine whether or not there is any normally situated thyroid If any amount is found, one may with impunity proceed with lingual thyroidectomy and assume on the basis of experimental evidence that the remaining portions of thyroid gland will undergo hyperplasia and care for the normal metabolic activity of the patient If normally situated gland is absent, it is imperative to adopt a conservative program Such medical measures as are of use in the treatment of other physiological enlargements of the thyroid should be tried In the presence of a low basal metabolic rate, mixed treatment with iodine and thyroid extract may be effective in reducing the size of the lingual goitre to the point where symptoms are relieved If the basal metabolic rate is normal or high, iodine alone should be given In event that medical treatment fails to reduce the size of the lingual goitre, thereby not relieving the obstructive symptoms partial or complete thyroidectomy must be done The electrosurgical knife may greatly facilitate this operation from the standpoint of its greatest technical hazard, i.e., hæmorrhage In the absence of other thyroid tissue, as determined by exploration, the excision of a lingual thyroid should be followed immediately by the administration of thyroid extract, regardless of the age of the patient

I am particularly interested in that group of patients with lingual thyroids who have only mild or moderate symptoms referable to it These patients should all be submitted to an exploration of the neck The examination

of the neck by palpation so frequently leaves one in doubt about the thyroid gland that I believe it is to the best interests of the patient, the family doctor and consultant, to know whether or not there is any thyroid tissue in or about its normal location. Exploratory operation entails so little risk, while the findings at operation are so valuable for the proper management of a case of lingual thyroid that one need not hesitate to recommend it. The high incidence of myxœdema after excision of a lingual thyroid from a patient of any age and the potential danger of arrested development, both physical and mental, in the young, justify this means of learning as much as possible about the patient from a thyroid standpoint.

In this group of patients, no active treatment should be directed toward the aberrant thyroid if no normally situated thyroid tissue is found, which in my opinion will be the rule rather than the exception. The program here should be one of watchful waiting with careful follow-up personally or through the family doctor, and the judicious use of iodine during the times of excessive physiological demands upon the thyroid gland.

**CASE REPORTS**—The following case reports are from the service of Dr. Charles H. Frazier at the University of Pennsylvania Hospital in Philadelphia.

**CASE I**—E. R. B., female, aged fourteen years, was admitted to University Hospital April 16, 1924, complaining of a tumor in her mouth. Sixteen months prior to admission she consulted her laryngologist because of some slight thickness of speech. He examined her for a return of tonsils and adenoids which he had removed four years previously. The only pathology found was a tumor at the base of her tongue. The child had never been conscious of its presence. A series of local remedies, the identity of which could not be determined, were applied, without appreciable change in the size of the tumor. The patient was returned to her family doctor, who prescribed iodides. The medication was taken for one year, during which time the tumor did not increase in size. Dyspnea had never been present. Frequently the child choked on food and drink. There had been no hæmoptysis. Physical and mental development normal to this point. Menses had been established for one year. No change in size of tumor noted during the periods.

*Past Medical History*—Measles, mumps and chicken-pox as a young child. Pneumonia at five years. Influenza at eight years. She was a healthy, well-developed child. The only demonstrable pathology was a well-defined tumor mass situated far back on the tongue, in the mid-line. Its color was red and contour smooth. It was moderately firm, was not tender and did not bleed when touched. Its posterior border was just anterior to the epiglottis. Its upper border was level with the highest point of the surface of the tongue. Examination of the neck by palpation revealed nothing suggestive of isthmus or lateral lobes of the thyroid. Basal metabolic rate was minus 8 per cent.

Through the regular thyroidectomy incision, the neck was explored (Dr. Francis Grant) April 26, 1924. Nothing in any way resembling thyroid tissue was discovered. The wound healed promptly and the patient was discharged May 1, 1924, without medication.

In spite of repeated follow-up requests the patient was lost until April 17, 1931, when her physician wrote: "I have just had the opportunity of examining E. R. B. She is in robust health now married and has two children. The lingual thyroid has possibly decreased slightly in size. She has no symptoms from it."

**CASE II**—R. B., female, aged three and one-half years, was admitted to the University Hospital May 31, 1930, with a chief complaint of clearing her throat. She had

no other complaints. Birth and development had been normal. In his examination of the child's throat during an attack of tonsillitis, just previous to admission, the family doctor discovered a tumor on her tongue. He had not treated it before this hospitalization.

*Past medical history* included whooping cough and an occasional sore throat. Examination was negative except for the findings in the mouth. Tonsils were moderately enlarged. On the base of the tongue in the mid-line was a reddish mass, symmetrical in form and shape, the size of the end of an adult thumb. It was not inflammatory or cystic. Direct laryngoscopic examination showed the tumor to be located well above the attachment of the epiglottis on the anterior pharyngeal wall (Fig 1). Our diag-



FIG 1—(Case II) R B—A—Drawing showing tumor as it appeared on examination of mouth. B—Appearance of tumor at direct laryngoscopic examination, showing relation to epiglottis. C—Schematic drawing of sagittal section showing relations of tumor.

nosis was lingual thyroid. On June 6, 1930, the patient was operated upon (Dr Henry F Ulrich) under ether anesthesia. The usual thyroidectomy incision was made, the ribbon muscles separated and a search for thyroid tissue was carefully made. None could be found. The wound was closed in the usual manner. The patient was discharged on June 11, 1930, without medication.

The last follow-up report from her physician March 31, 1931, says "I have just examined R B. She seems to be normal in growth compared to her other sisters. Her only symptom is slight pharyngeal irritation. The lingual thyroid has in my opinion decreased in size."

## LINGUAL THYROID

*Comment*—Both of these cases represent that group of cases in which the symptoms are very mild. There was little doubt concerning the amount of thyroid tissue each possessed. The subsequent course of each, particularly the first, satisfies us that everything was gained for the patient and nothing lost as a result of our refusal to direct active treatment to the lingual thyroid. It is of special interest to note that the first patient has been subjected to the physiological demands of two pregnancies with no untoward symptoms referable to her thyroid.

### SUMMARY

(1) A brief mention has been made of some of the unfortunate sequelæ of lingual thyroidectomy.

(2) It is suggested that all patients with lingual thyroid, when treatment is sought, should be submitted to an exploration of the neck.

(3) Patients with severe symptoms requiring lingual thyroidectomy should be placed on thyroid extract therapy immediately.

(4) A policy of watchful waiting is urged in cases of lingual thyroid with mild symptoms, especially if no other thyroid tissue is demonstrable.

(5) Two cases of lingual thyroid with follow-up notes are reported.

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# CARDIAC FEATURES OF GOITRE\*

WITH SPECIAL REFERENCE TO OPERATION

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THE prominence of cardiac disturbances in goitre was recognized by the early writers on the subject, and as long ago as 1815 Parry<sup>10</sup> considered alterations in cardiac action and function associated with exophthalmic goitre. Similarly, Graves,<sup>5</sup> in 1835, von Basedow,<sup>1</sup> in 1840, Stokes,<sup>19</sup> in 1854, and Tiousséau<sup>20</sup> in 1856, emphasized the cardiac features of goitre.

In considering the cardiac disturbances attending goitre we are concerned chiefly with exophthalmic goitre and with hyperfunctioning adenomatous goitre. Early observers, such as Potain,<sup>14</sup> in 1863, and Rose,<sup>16</sup> in 1878, described cases of heart failure and sudden death, presumably due to enormously large, nodular, and colloid goitres causing pressure on the veins and trachea. Cases of this nature have become so unusual that we deem it inadvisable to include them in this consideration.

*Physiological Alterations*—The physiological changes which occur in both exophthalmic goitre and hyperfunctioning adenomatous goitre are mainly dependent on the increased basal metabolic rate. The most prominent cardiac effect of hyperthyroidism is excessive rapidity of the beat. An increase in metabolism is accompanied by an increased demand of tissue for oxygen, the demand is met by increasing the amount of air breathed each minute and by alterations in the circulatory system that favor an increased rate of flow of blood. Acceleration of cardiac rate is the first attempt of the body to increase flow of blood, and is a usual accompaniment of increases in basal metabolic rate.

Both exophthalmic goitre and hyperfunctioning adenomatous goitre usually are attended by alterations in blood-pressure. The most important of the changes in blood-pressure is increase in pulse pressure. In exophthalmic goitre the pulse pressure is slightly greater, average readings in the series of cases seen at The Mayo Clinic were 74 millimetres in exophthalmic goitre and 70 millimetres in hyperfunctioning adenomatous goitre. This increase in pulse pressure is affected, in exophthalmic goitre, by a slight rise in systolic pressure (to 147 millimetres†) and frequently a slight drop in diastolic pressure (to 73 millimetres) and in adenomatous goitre, by a decided rise

\* Read before the Southern Surgical Association, December 8, 1931.

† The values for blood-pressure are averages obtained in readings of a large series of cases.

## CARDIAC FEATURES OF GOITRE

in systolic pressure (to 153 millimetres) which more than offsets a slight rise in diastolic pressure (to 83 millimetres)

Interpretation of these alterations in blood-pressure is facilitated by referring to previously conducted physiological investigation. Eilanger and Hooke's<sup>4</sup> work suggested the fact that the velocity of flow of blood was indicated by the product of pulse rate and pulse pressure, and von Recklinghausen held that the pulse pressure varied with the systolic output of the heart, provided that arterial elasticity was normal. Additional work has demonstrated that the minute volume output of the heart is increased in proportion to the increase in metabolism,<sup>2, 8</sup> and that an increase in stroke volume and minute output occurs in exophthalmic goitre.<sup>15</sup>

In a recent publication, Chang<sup>2</sup> described the results of his experiments on blood volume in exophthalmic goitre. He studied twenty-one subjects and found a definite increase in the volume of circulating blood. In applying this finding to clinical states he emphasized the fact that in exophthalmic goitre the blood supply of the thyroid gland was increased and that the rather extensive capillary bed of the neck may act as a shunt for a considerable portion of the blood. He commented on the similarity of this status with that occurring in arteriovenous fistula. Holman<sup>7</sup> has demonstrated that the gradually increasing dilatation of the vascular bed in arteriovenous communication is compensated for by a proportionate increase in blood volume, and that the volume is restored to normal by closure of the arteriovenous channel.

Thus, in cases of hyperthyroidism, clinical signs involving the circulatory system, such as tachycardia, palpitation, increase in pulse pressure, the tendency to flushing and sweating, basal cardiac murmurs, and occasionally the occurrence of bruits in the peripheral arteries, are well explained by an increase in the rate of circulation.

*Pathology*—In the hearts of patients who died in the active stage of hyperthyroidism, there are no distinctive histopathological changes. Wilson<sup>21</sup> has described lipid changes and swelling of the muscular fibres, with indistinct striations. The myocardium is frequently pale, soft and somewhat dilated. These changes, however, are not pathognomonic of hyperthyroidism, for they occur in such diseases as pneumonia, pernicious anaemia, leukæmia, and the cachexia of carcinoma.

Considerable difference of opinion exists among clinicians regarding the occurrence of cardiac hypertrophy resulting from hyperthyroidism. Some maintain that cardiac hypertrophy occurs only when some primary and independent cardiac lesion exists, in itself capable of increasing the mass of cardiac muscle. We cannot accept this viewpoint, for in the series seen at The Mayo Clinic, numerous instances of cardiac hypertrophy have been demonstrated by necropsy (15 per cent), increases have been noted of 100 to 200 grams beyond the accepted standard of Smith,<sup>18</sup> based on age, height and weight, in cases in which primary cardiac disease was absent. Furthermore, Simonds and Brandes<sup>17</sup> produced cardiac hypertrophy in healthy

dogs by experimental production of hyperthyroidism from feeding of thyroid substance. Our experience indicates that hyperthyroidism must exist a considerable period of time to produce cardiac hypertrophy. Furthermore, if the known physiological influences on the circulation of increased metabolism are interpreted in terms of increased work, it is not amiss to expect cardiac hypertrophy to occur in some cases. The effect on the heart muscle of thyroxin either in excessive quantity or in abnormal form, is not understood, and conclusions concerning this aspect of the problem cannot be drawn at this time.

*Clinical Features*—In examination of patients with hyperthyroidism, the most impressive cardiac finding is rapid and tumultuous cardiac action, this is usually more pronounced in exophthalmic goitre. The impression that the heart is definitely enlarged is frequently obtained, owing to the rapid, visible, wavy, and forcible apex beat. Dilatation to some extent probably occurs rather commonly, as was indicated by Wilson's<sup>21</sup> studies made of material obtained at necropsy. However, the overactive circulation in hyperthyroidism may erroneously suggest enlargement of the heart, and caution must be exercised in interpretation of existing signs.

Murmurs, systolic in time, are commonly audible in the cardiac area, and occur chiefly at the apex and at the second left intercostal space. They vary in intensity and in transmission. The murmurs are usually less intense when the patient is at rest, and become augmented under stress, indicating their close relationship to increases in rate of circulation. The apical systolic murmur may at times be the result of relative mitral insufficiency.

Unless caution is used, the presence of murmurs may erroneously be interpreted as being indicative of endocardial valvular disease. The most common erroneous diagnosis is mitral stenosis, particularly if the apical systolic murmur is rough and prolonged, thereby giving the impression of being presystolic in time. This false evidence may be supplemented by what appears to be a thrill resulting from the tumultuous cardiac action.

Endocardial valvular disease is associated with hyperthyroidism, but not as frequently as current diagnoses would indicate. When present, its incidence is greater in association with exophthalmic goitre than with hyperfunctioning adenomatous goitre, owing to the dominant occurrence of both exophthalmic goitre and endocardial valvular disease among patients of the younger ages.

Auricular fibrillation is the most common disorder of rhythm, it occurs in about a fourth of the cases of both of the diseases of the thyroid gland which are under consideration. It is present as a persistent mechanism in about 10 per cent of the cases, it appears in a paroxysmal manner, with rapid rate, in about 5 per cent of the cases, and it occurs intermittently, without unduly rapid rate, ultimately disappearing after the arrest of the disease, in about 10 per cent of the cases. The persistence of auricular fibrillation following thyroidectomy is suggestive of the presence of associated

primary cardiac disease, residual cardiac injury from protracted hyperthyroidism, or recurrent hyperthyroidism of exophthalmic goitre

When auricular fibrillation affects patients of middle life or later life, attention should at once be directed to the possible presence of thyroidism, particularly of hyperfunctioning adenomatous goitre. Not infrequently, patients are treated for a considerable period for what is believed to be heart disease, when in reality the cardiac phenomena are but the expression of unrecognized hyperthyroidism. Needless to say, the loss of time involved in such treatment may be the determining factor between chronic invalidism and death, or cure by surgical intervention.

The presence of auricular fibrillation does not necessarily increase surgical risk, it is frequently present when cardiac injury is minimal. However, the crucial points in determining surgical risk are the degree and extent of myocardial injury and the ability of the heart to adjust itself sufficiently to maintain a fairly normal circulation.

The occurrence of congestive heart failure in the course of hyperthyroidism has been the basis for considerable controversy. There appears to be a rather widespread belief that when congestive failure occurs it is evidence of associated and independent cardiac disease, and that hyperthyroidism itself is not capable of producing heart failure. The incidence of independent cardiac disease in patients with goitre is, of course, not unlike that of independent cardiac disease in patients of similar age groups who have diseases other than goitre. Nevertheless, that congestive failure solely as the result of hyperthyroidism does occur, even though its occurrence is infrequent, has been proved many times by careful correlations of clinical data and results of necropsy. Hypertensive heart disease and coronary sclerosis are not uncommon among patients with hyperthyroidism. These cardiac conditions occur most frequently in cases of hyperfunctioning adenomatous goitre owing to the similar incidence by age groups. The occurrence of angina pectoris in patients with hyperthyroidism has received considerable attention<sup>6, 9</sup> and recently Haines and Kepler<sup>6</sup> recorded their observations. They recorded distinct improvement in the anginal syndrome in most of the cases following partial thyroidectomy, and concluded that in their series, the risk was not so great as to preclude operation. Removal of the added work from the heart was believed to have been the basis for the improvement.

*Preoperative Treatment*—When congestive heart failure is absent, the heart usually does not require special treatment. The exception to this is the heart with auricular flutter, if this condition persists after a reasonable period of rest and administration of compound solution of iodine<sup>13</sup> in doses of 10 minims three times daily, the use of quinidine sulphate is advisable. This drug, however, must be given with discretion, and twenty-four to forty-eight hours must be consumed in determining the patient's tolerance to it. It is our custom to administer 3 grains three times daily for this period of time, and if no idiosyncrasy to the drug is evident, the dosage is increased.

to 4 grains every four hours day and night, until the flutter has been abolished. It is at times necessary to give as much as 30 to 40 grains in twenty-four hours.

Auricular fibrillation rarely demands special treatment. Unless complications exist, the period of preoperative rest rarely exceeds two weeks.

When congestive heart failure is present the treatment is similar to that of primary heart disease without hyperthyroidism. However, digitalis should be employed with great caution, and ordinarily it is not used at once. Administration, by mouth, of ammonium nitrate in its enteric form, in doses of 6 grains daily, and intermittent intravenous injection of salyrgan (mersalyl), in doses of 1 to 2 cubic centimetres, usually suffices to rid the body of the oedema fluid and to restore cardiac function. When this method does not prove efficient, although it rarely fails, and when rapid auricular fibrillation persists judicious use of digitalis is advisable. However, every effort should be made to avert toxic phenomena.

It should be recalled that the action of digitalis on the diseased heart of man is essentially twofold, the objections to its indiscriminate use are evident. Many actions ascribed to digitalis do not occur, or are purely secondary effects, resulting from improvement of the general circulation. Digitalis slows the cardiac rate by its direct action on the vagal endings, and to some degree by its action on the vagal centre. It is particularly effective in auricular fibrillation when ventricular action is rapid. It usually does not cause slowing of the pulse rate in cases of hyperthyroidism unless cardiac failure is an accompaniment. Digitalis increases the amplitude of cardiac contraction by its direct action on the myocardium. With these actions clearly in mind it becomes evident that indiscriminate administration of digitalis is undesirable in hyperthyroidism. Our experience has indicated that administration of the drug should be discontinued for at least four or five days preceding operation to insure the tissues' not being affected by its cumulative effects.

When cardiac function is restored, the patient should be gradually returned to limited activity before subjecting him to a surgical procedure. As has been repeatedly emphasized it is unsafe to undertake operation on any patient who has been debilitated by a long period of complete rest. Under such conditions, circulation becomes sluggish, resistance lowered and the patient is particularly susceptible to respiratory infection and venous thrombosis, the latter of course predisposing to fatal embolism. Furthermore a short period of physical rehabilitation affords a test of cardiac reserve. For should heart failure again supervene under this program, it is fairly conclusive evidence that operation at that time was contraindicated. In such an event the need for prolongation of the period of preparation is obvious.

Probably in no other cardiac disturbances has treatment been followed by more brilliant results than those obtained by partial thyroidectomy in cases of "goitre heart." Certainly in no other cardiac disorder of such wide

spread occurrence can complete and often permanent function be so promptly restored, with relatively little risk. The relief of the cardiac manifestations of arteriovenous aneurism by the permanent closure of the fistula is alone comparable. Presence of the more common cardiac manifestations of toxic goitre, that is, alterations in rate and rhythm, in the absence of congestive heart failure rarely constitute additional factors in the operative hazard, and accordingly do not usually demand any additional measures in the operative and postoperative periods. The complete and usually permanent subsidence of these disorders within two or three weeks following partial thyroidectomy is well known. A very large percentage of patients with congestive heart failure, who without operation are apparently doomed to a limited existence of chronic invalidism, will easily withstand partial thyroidectomy, subsequently regain complete cardiac efficiency, and enjoy many years of active and useful life. However, it should be clearly recognized that operation on these patients, as a group, entails a risk appreciably greater than if the hyperthyroidism is uncomplicated.

The relation of the liver to surgical risk in hyperthyroidism and in other diseases has not received sufficient consideration. The liver, one of the largest organs of the body, is likewise one of the most vital, and failure of its function is very serious. Much information has been gained regarding its functional integrity by the newer methods of estimation of function, particularly by the bromsulphthalein test. Impairment in hepatic function occurs frequently in hyperthyroidism, but knowledge of the pathological changes is as yet incomplete. Considerable degrees of atrophy of the liver are not unusual findings. Patients with retention of dye of high grade constitute very poor surgical risks, apparently indicating that the threshold of hepatic function is narrow, and that additional stress may be sufficient to cause death.

The debility of the patient, commonly proportionate to the duration of the hyperthyroidism, the degree of hepatic injury, and the basal metabolic rate are more accurate indicators of operability than the severity of the cardiac disorder. Patients who do not survive the operation rarely die of congestive heart failure, but more commonly of pulmonary infection, hepatic insufficiency, or arterial emboli.

In order to permit us to place quantitative values on the statements just made, we selected for review 100 consecutive cases of congestive heart failure accompanying exophthalmic goitre, and 100 consecutive cases of hyperfunctioning adenomatous goitre. The patients all had œdema of dependent parts, the minimal degree was Grade 2. The average duration of hyperthyroidism in the cases of exophthalmic goitre was 24.6 months and in adenomatous goitre with hyperthyroidism twenty-five months. The average duration of hyperthyroidism in patients with exophthalmic goitre who come to operation is about fourteen months.

Of the 100 patients with exophthalmic goitre, only one died of heart failure, this patient failed to respond to medical treatment and operation.

was not attempted. Four patients died following thyroidectomy, death resulting from pneumonia in two cases and from thyroid crisis in two. The latter two cases occurred before the period of the iodine treatment of exophthalmic goitre.

In the 100 cases of hyperfunctioning adenomatous goitre, death occurred in five cases following thyroidectomy. Heart failure was responsible for death in two cases, hepatic cirrhosis with insufficiency in one case, cerebral hemorrhage in one case and pulmonary embolism in one case.

We wish to emphasize the fact, previously reported<sup>12</sup> that although it is possible, from a clinical estimate of the hazard to select from among patients with goitre a small group (19 per cent) who are handicapped, from which 81 per cent of the total mortality will be derived, it is not possible to foretell accurately which individual patient will not survive the operation. Therefore it is our opinion that when faced with the serious problem of deciding for or against operation on a patient who has marked decompensation of the heart and whose chances of recovery seem exceedingly remote, the duty of the conscientious surgeon is clear-cut: he should take into consideration that his estimate of the hazard is subject to error and that every patient should be given his one chance irrespective of the risk involved.

*Surgical Treatment*—Although a detailed description of the operative technic is clearly beyond the scope of this paper, we wish to stress certain principles which in our experience have proved of definite value. Owing to the fact that the margin of safety in many of the cases is exceedingly narrow, as sometimes the slightest mishap will mean the difference between success and failure, the need for the greatest possible care in every phase of the operation is obviously indicated. In the selection of the anæsthetic and the method of its administration there are two considerations of extreme importance. (1) Since all of the patients are more or less debilitated and therefore particularly susceptible to pulmonary infection, the type of anæsthesia which is least likely to contribute to this complication should be chosen, and unquestionably prolonged anæsthesia by inhalation should be avoided, and (2) the anæsthesia should be such that the patient can be awakened in a reasonable state of comfort after resection of the first lobe in order that the functional integrity of the inferior laryngeal nerve can be determined. The value of this is obvious, and in our opinion it is the most important single step in the operation. It has been our experience that combined anæsthesia, namely infiltration with procaine hydrochloride (0.5 per cent) supplemented by nitrous oxide and oxygen by inhalation, most nearly fulfills these requirements. Under this method the average duration of the administration of gases is from eight to ten minutes. For patients with obstructive dyspnea a local anæsthesia is definitely indicated.

Not uncommonly, in cases of congestive heart failure there may be circumstances relating to the condition of the patient or to the difficulty of the operation, such that performance of the operation in stages with a term

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ally minimize the hazard. The indications for this have previously been fully considered <sup>11</sup>

Too often the surgeon is prone to believe that the outcome of an operation is favorably influenced to only a limited degree by any measure instituted after the patient has left the operating room, and it is true that a large proportion of these patients does not require any treatment other than symptomatic measures employed as a routine. However, not uncommonly grave complications develop, such as obstructive dyspnoea, hyperthyroid reactions, pulmonary oedema and infection, and since the successful treatment of these is dependent on early recognition of impending signs and prompt institution of proper treatment, close supervision by an experienced clinician is indispensable. It is for this type of complication, associated with cyanosis, that treatment by oxygen, preferably in the oxygen chamber or tent, has proved to be of great value.

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# THE USE OF POTASSIUM IODIDE IN HYPERTHYROIDISM\*

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As GOITRE is not endemic in this territory, one would not presume the Thyroid Clinic to be of major importance, yet at the University Hospital we have records of over 4,200 cases. And as goitre is not endemic in this zone, the vast majority of the cases on our records are of the toxic variety. For some reason or other the incidence of toxic goitre is increasing notably year by year and the disease is developing more rapidly. It is also true that many more patients are being referred to the clinic in the incipency of the disease.

The widespread use of iodine in the treatment of goitre in the last eight or nine years has caused the belief to be more or less general that this type of therapy is quite new, when in reality it is of very ancient origin. Sponge ash, which contains iodides, was used for its beneficial effect on goitre by the Chinese surely a thousand years before the Christian era. Hippocrates and Galen were familiar with its effect in goitre, as were many of the clinicians who practiced after Thomas Wharton accurately described the thyroid gland and gave it its name in 1659.

Iodine was first isolated by the French chemist Courtois,<sup>1</sup> in 1811. Nine years later, Coindet,<sup>2</sup> of Geneva, wrote of a new substance for the control of goitre. Soon reports appeared of the untoward effects of iodine therapy in certain types of goitre. Gaidner<sup>3</sup> described these symptoms which we now recognize as those referable to thyrotoxicosis, and Theodor Kocher,<sup>4</sup> in 1910, called this condition "Iodin-Basedow's."

For over one hundred years medical opinion was divided as to whether iodine should or should not be used in the treatment of any thyroid disorder. Within our own time I think we may justly say that its use was limited or given up entirely as a result of the influence of Kocher, who was definitely opposed to its use. Fortunately for the patient suffering from thyrotoxicosis, the pendulum has swung to the right as clinicians began to realize the import of investigations of physiologists and chemists in this very important field.

In 1896, Bauman<sup>5</sup> reported the presence of iodine in the thyroid gland, and isolated a substance which he called iodothylin. Oswald,<sup>6</sup> a year later, found iodine in the thyroid colloid and stated that in general the iodine content of the gland varied with the amount of visible colloid. Fenger<sup>7</sup> found iodine in the thyroid gland of cattle as early as the third fetal month.

The investigations of Marine and his co-workers have been among the most noteworthy in this field. Marine and Williams (1908)<sup>8</sup> and Marine and Lenhart (1909)<sup>9</sup> published their investigations on the relationship of

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\* Read before the Philadelphia Academy of Surgery, November 2, 1931.

iodine to the histological structure of the thyroid in man and animal. They demonstrated conclusively that the iodine store in the thyroid was directly proportional to the amount of stainable colloid and inversely proportional to the degree of hyperplasia. The ability of the thyroid to store iodine was convincingly shown by Marine,<sup>10</sup> in 1915, when he reported that as much as 18.5 per cent of a single dose of thirty-eight milligrams of potassium iodide administered to the dog by mouth could be stored in the thyroid within two hours.

In 1929, Dr. W. B. Moser and I<sup>11</sup> reported investigations before this society which confirmed Marine's findings, that the administration of iodine caused a rapid involution of thyroid hyperplasia with an increase of colloid in the thyroid acini. We believed, and still believe, that the improvement in the clinical picture of hyperthyroidism after iodine administration is due to the increased colloid formation under iodine stimulation, resulting in a flattening of the acinar cells.

It is impossible to discuss the entire history of iodine in relation to the thyroid, but one should not leave the historical aspects of this subject without mentioning that it remained for an American chemist, Kendall,<sup>12</sup> to isolate the iodine-containing hormone, thyroxine. Twelve years later, Harrington<sup>13</sup> gave this substance its proper chemical formula.

Although Oswald<sup>14</sup> and A. Kocher<sup>15</sup> had adequately described the effect of iodine therapy in exophthalmic goitre, it remained for Plummer and Boothby<sup>16</sup> to give this therapy a more exact status. It is due to their careful observations that this type of therapy as a pre-operative adjunct has become a rational part of the surgeon's armamentarium. Even before these workers had published their results, there were references in the literature which, had they been accepted, would have reduced the mortality after operations for hyperthyroidism considerably. Thus Cheadle,<sup>17</sup> in 1869, and again in 1875, reported that iodine therapy gave temporary beneficial results in Graves' disease. Loewy and Zondek,<sup>18</sup> in 1921, reported that small doses of potassium iodide definitely improved the subjective symptoms of the patient and caused a reduction of the basal rate.

The investigations of Plummer and Boothby were noteworthy because theirs was the first large series of cases in which metabolism studies were made. Although Plummer's concept of its action is, I believe, open to serious question, the accuracy of his clinical observations is unassailable. He believed that in Graves' disease the thyroid produces an incomplete thyroxine, and Gaddum<sup>19</sup> has shown that thyroxines containing less than four molecules of iodine have less effect on the basal rate than has the complete product.

Plummer and Boothby stated that they used "Lugol's solution (which contains 5 per cent of free iodine, and 10 per cent of potassium iodide) because it contained a large amount of iodine loosely combined." It would seem that they believed that free iodine was more readily absorbed from the gastro-intestinal tract than other forms of iodine.

## POTASSIUM IODIDE IN HYPERTHYROIDISM

The actual amount of thyroid iodine necessary for normal function is indeed small. The maximum storage of iodine per gram of dried weight is from five to six milligrams, and the maximum iodine content of the normal adult thyroid is from twenty-five to thirty milligrams. This has led many investigators to question the utility of using large doses of iodine in Graves' disease. Although Means<sup>20</sup> and his co-workers are probably correct in stating that small doses, a minimum of Lugol's solution a day, will often give beneficial results in these cases, the fact remains that decided improvement in our experience does not occur in every case with such small doses. Furthermore, it should be stated definitely that iodine is not a cure for Graves' disease. Its effect is temporary, and advantage should be taken of its temporary beneficial effect for operative intervention. The continued use of iodine will cause a recurrence of the original symptoms, and, at this time, the histological structure of the gland will frequently show a markedly disordered structure.

Although the results obtained by Loewy and Zondek followed the administration of potassium iodide, clinicians in general have used Lugol's solution as suggested by Plummer and Boothby. Recently Lerman and Means<sup>20</sup> have shown that ethyl iodide by inhalation or iodide by mouth gave clinical improvement similar to that to be expected from the use of Lugol's solution.

During the past year, Cohn,<sup>21</sup> in the Laboratory of Research Surgery at the University of Pennsylvania, has given us additional information on this very important subject. He has, I think, conclusively proven that free iodine must be converted into an iodide before it is absorbed from the gastro-intestinal tract. The conversion in isolated gut segments takes place with exceeding rapidity. These latter observations we have recently confirmed in that we can find no free iodine in our solution fifteen minutes after it is placed in the gut.

Cohn studied the absorption of solutions of free iodine, iodides and Lugol's solution from different gut segments and found that on the whole the iodine is absorbed more rapidly when it is introduced as an iodide.

If the observations are applicable to the human as they undoubtedly are, there is no reason why Lugol's solution should be continued in use. It is not pleasant to taste and frequently causes some gastro-intestinal discomfort. It only remained to be seen whether Loewy and Zondek's observations on the reduction of the basal rate could be confirmed in a study of a large series of cases. Since Lerman and Means' investigations were published this summer, the significance of Cohn's work has taken on a new aspect.

We have used sodium iodide exclusively on the thyroid service in preparing our patients with all types of hyperthyroidism during the past three months. Its effect has been just as striking as was the effect of Lugol's solution and the patients have not complained of the disagreeable effects of free iodine administration.

During the course of the investigation, we have operated on fifty patients, whose pre-operative medication has consisted of potassium iodide, sedatives, and such other therapeutic agents as were indicated. No Lugol's solution was used. For the sake of uniformity, all patients have received daily one cubic centimetre of a saturated solution of potassium iodide which contained one gram of the iodide. The pre-operative management of these patients did not vary in any other particular from that formerly used on the thyroid service. The usual time for preparation varied from seven to ten days. The time required was longer for decompensated patients. The use of patients for teaching and for other clinical investigations as well as delays in transfer from the medical to the surgical wards were other factors partly responsible for the average of eleven days which you will see in the records of cases that I will show.

In all of the cases there was a gratifying improvement in the general clinical picture, a steady decline in the pulse rate, and a decrease in the metabolic rate.

For the sake of comparing the effect of Lugol's solution and potassium iodide on the basal metabolic rate, we have compiled comprehensive tables of unselected cases of both types of toxic goitre, *i e*, hyperplastic toxic and toxic adenoma, showing the pre-operative decline in metabolic rate.

Table I shows the effect of Lugol's solution on the basal metabolic rate in hyperplastic toxic goitre.

TABLE I

*Hyperplastic Toxic Goitre*

Pre operative decline of basal metabolism after administration of iodine	
Average reading on admission	54.8
Average pre-operative reading	27.7
Average decline	27.1
Per cent decline	49.4

Table II shows the effect of potassium iodide on the basal metabolic rate in hyperplastic toxic goitre.

TABLE II

*Hyperplastic Toxic Goitre*

Pre-operative decline of basal metabolism after administration of potassium iodide	
Average reading on admission	55
Average pre-operative reading	29
Average decline	26
Per cent decline	47.3

Table III shows the effect of Lugol's solution on basal metabolic rate in toxic adenoma.

# POTASSIUM IODIDE IN HYPERTHYROIDISM

TABLE III

## Toxic Adenoma

Pre-operative decline of basal metabolism after administration of iodine

Average reading on admission	39
Average pre-operative reading	25
Average decline	16
Per cent decline	40 per cent

Table IV shows the effect of potassium iodide on basal metabolic rate in toxic adenoma

TABLE IV

## Toxic Adenoma

Pre-operative decline of basal metabolism after administration of potassium iodide

Average reading on admission	31
Average pre-operative reading	17
Average decline	14
Per cent decline	45 per cent

We were interested to find that the figures we obtained in this small series of cases so nearly paralleled those of the much larger series of cases prepared with Lugol's solution

To illustrate graphically the progress of our patients during their hospitalization, we chart daily the highest pulse rate recorded by the nurse. We also enter the metabolic rate under the day on which it was measured. The following cuts were made from such charts in our records of several representative cases. The pathological diagnosis confirmed our clinical diagnosis

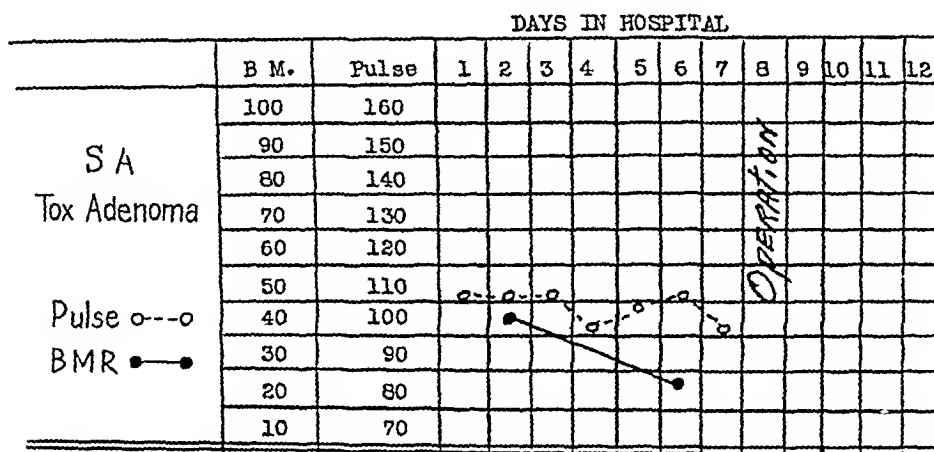


Fig 1

The first patient (Fig 1) was a woman of forty-seven years of age. She was known to have had an adenomatous goitre for twenty years. Symptoms of toxicity had been present for six months before admission. Our diagnosis was toxic adenoma. There was nothing eventful about her course in the hospital.

The second patient (Fig 2) was a woman fifty-four years of age. She was known to have had an adenomatous goitre for at least seven years with symptoms of toxicity for



# CHARLES H FRAZIER

six months She had several abscessed teeth and infected tonsils She had a subacute arthritis, probably infectious in origin, but without febrile reaction She had also a

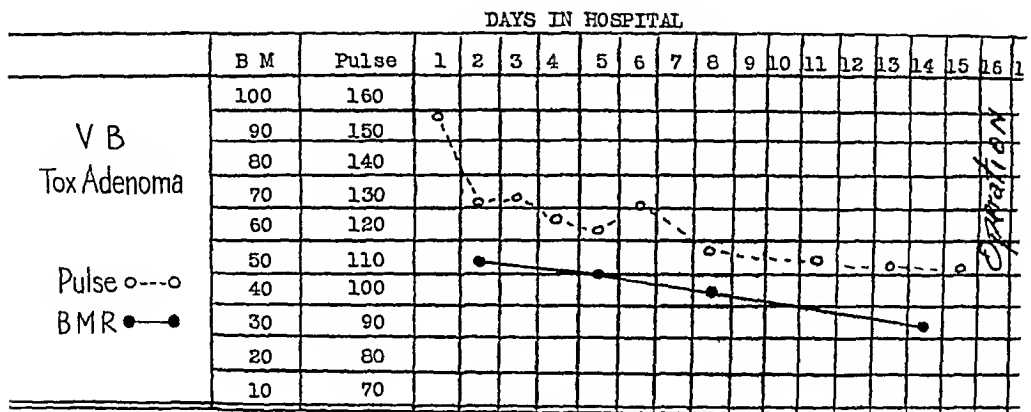


FIG 2

moderate degree of cardiac decompensation which prolonged her preparation Her post-operative course was uneventful until discharge on the ninth day

The third patient (Fig 3) was an unmarried woman, thirty-eight years of age, who

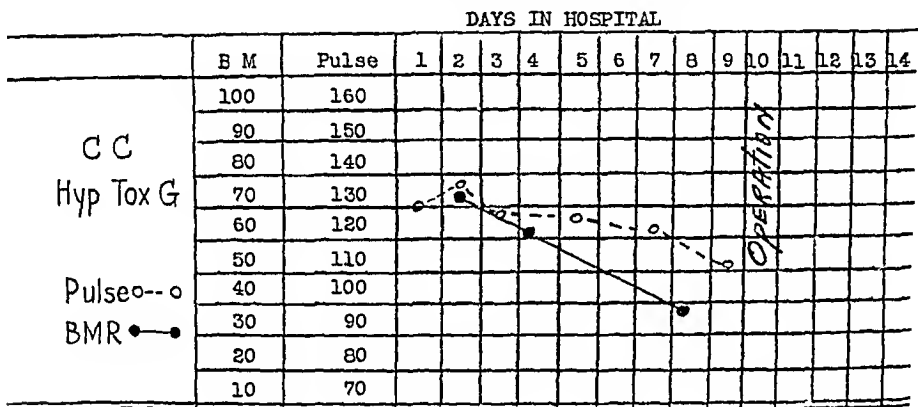


FIG 3

developed rather marked symptoms of thyrotoxicosis eighteen months ago Thyroid enlargement was first noted four months ago She had lost twenty-five pounds in weight Exophthalmos was very marked Our diagnosis was hyperplastic toxic goitre She was

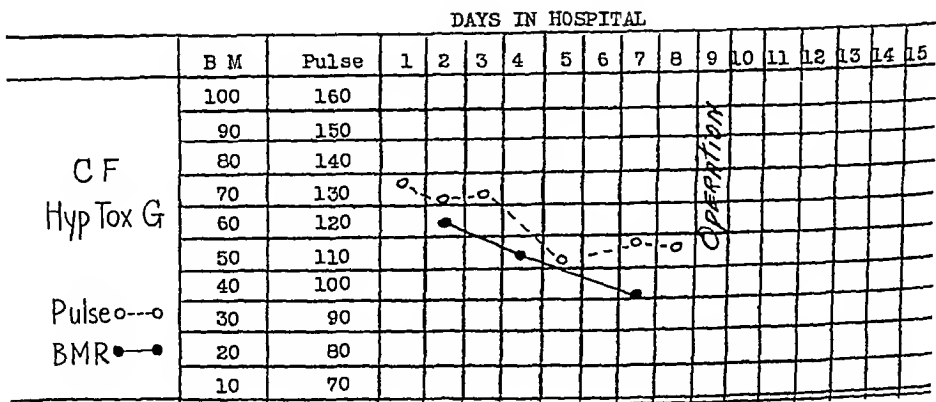


FIG 4

# POTASSIUM IODIDE IN HYPERTHYROIDISM

discharged from the hospital on her eighth post-operative day with a metabolic rate of plus 9 per cent

The fourth patient (Fig 4) was a married woman, thirty years of age, the mother of three normal, healthy children. The classical signs and symptoms of hyperplastic toxic goitre developed four months before admission and one month after the birth of her last child. Moderate exophthalmos had already appeared. Her clinical course in the hospital was entirely satisfactory. On the eighth day after thyroidectomy she left the hospital with a metabolic rate of plus 18 per cent.

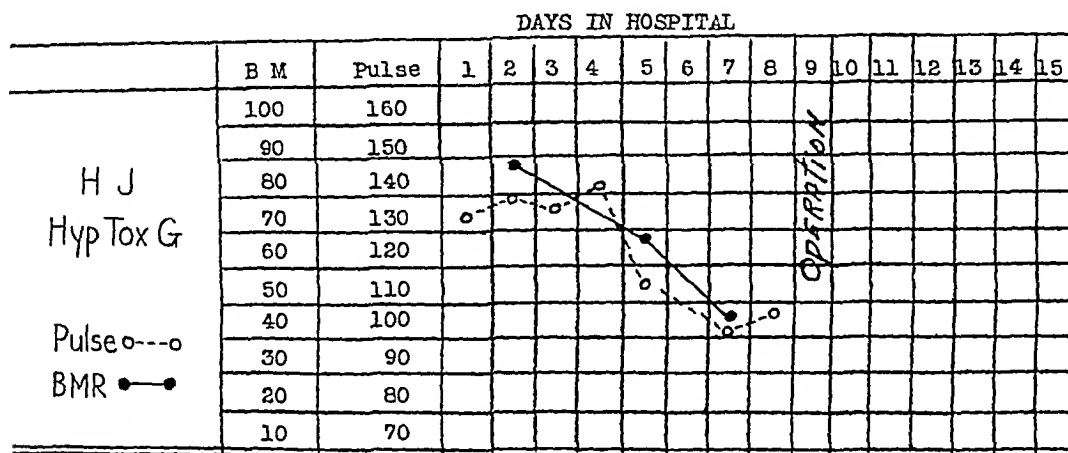


FIG 5

The fifth patient (Fig 5) was a man, thirty-four years of age, who developed thyrotoxicosis seven months ago. Four months ago he first noticed thyroid enlargement and beginning exophthalmos. The latter had progressed until it was marked on admission. He had lost sixty pounds during his illness. He stood thyroidectomy well and left the hospital on the eleventh post-operative day with a metabolic rate of plus 1 per cent.

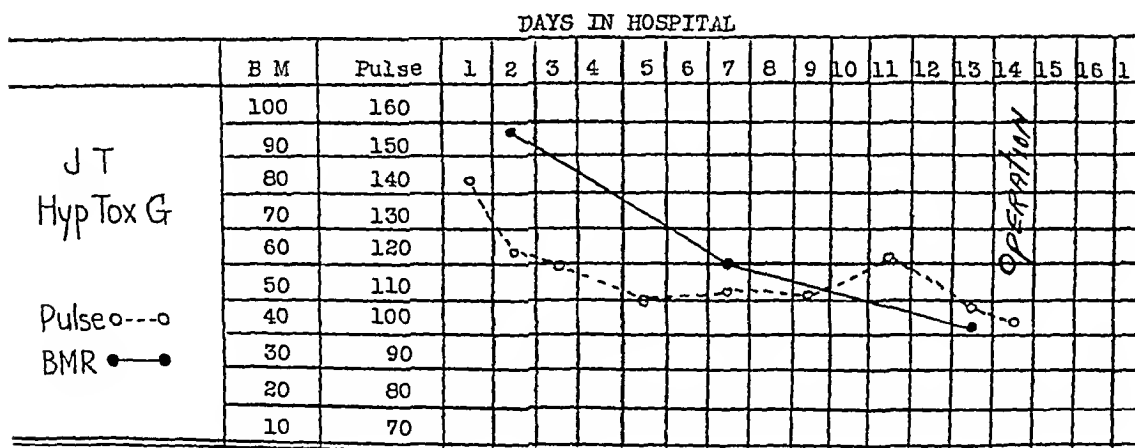


FIG 6

The sixth patient (Fig 6) was a girl, twenty-two years of age, who said she had had thyroid enlargement since adolescence. Marked symptoms and signs of hyperplastic toxic goitre developed five months before admission. One month later her thyroid rapidly enlarged until it had the appearance of a large colloid goitre. Exophthalmos was severe. Because of her age and toxicity, her pre-operative preparation was slightly prolonged. She had a sharp post-operative reaction but left the hospital on the tenth day with a pulse rate of 90 and a metabolic rate of plus 16 per cent.

## SUMMARY AND CONCLUSIONS

(1) A series of cases of both forms of toxic goitre is reported, which were prepared for operation with potassium iodide

(2) The general improvement noted as well as the specific improvement in pulse and metabolic rate, paralleled the improvement obtained by Lugol's solution

(3) The clinical charts of several representative cases have been exhibited which graphically show the pre-operative response of thyrotoxicosis to potassium iodide

(4) We conclude from the evidence obtained in our Surgical Research Laboratory that free iodine, to be absorbed, must be converted into an iodide, and from our clinical investigation, that it appears unnecessary to have free iodine "loosely combined," to which quality has been ascribed the effect of the administration of Lugol's solution on hyperthyroidism

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## A SIMPLIFIED TECHNIC IN THYROIDECTOMY

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FROM THE SURGICAL SERVICE OF ST. ANDREW'S

IN RECENT years thyroid surgery has ceased to be such a formidable procedure. It is no longer necessary nor advisable to submit the patient to a long tedious dissection. The long curved incision with a wide upward dislocation of the neck skin takes time, is unnecessary, and leaves a needlessly ugly



"Old Collar Incision"



Small Straight Incision

FIG. 1.—As 90 per cent of thyroidectomy are performed in women the element of cosmetic appearance is an important one.

scar. The transverse division of the neck muscles is equally unnecessary except on occasional very large goitre or one that presents some exceptional technical difficulty. The following technic is simple, quick, and lessens the magnitude of the usual thyroidectomy.

A small incision is made straight across the neck fairly low in relation to the gland—approximately three-fourths of an inch above the sternum. There is no need to curve the incision, as the normal anatomical curve of the neck will secure this appearance in the finished scar. Through this section of the skin and platysma a wide undermining is accomplished. There is nothing of importance in this area to fear injuring so that dissection may be rapidly performed. This freely exposes the underlying ribbon muscles of the neck from the sternum to the thyroid cartilage and from one sternomas-

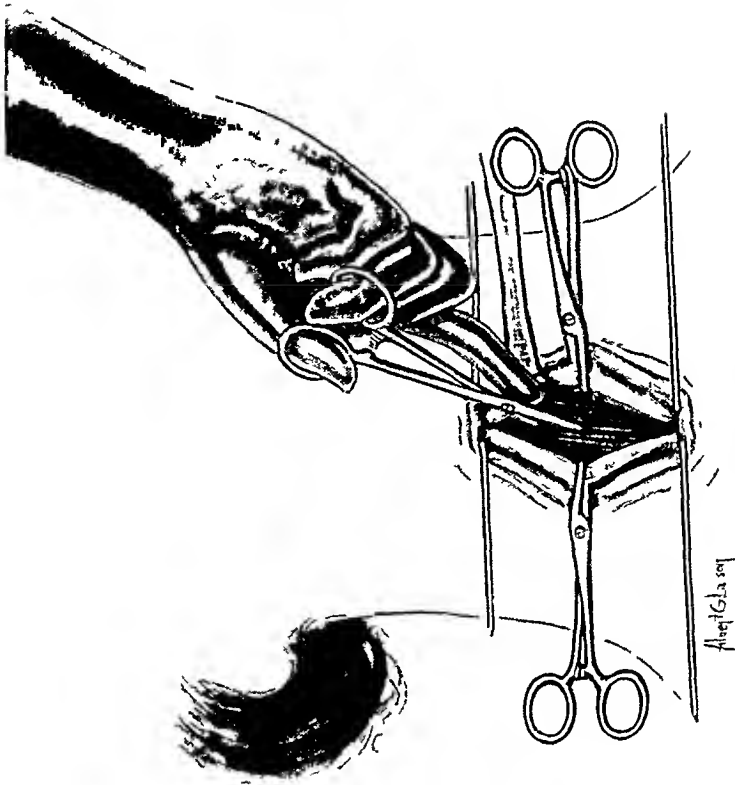


FIG 3.—Longitudinal division of prethyroid muscles

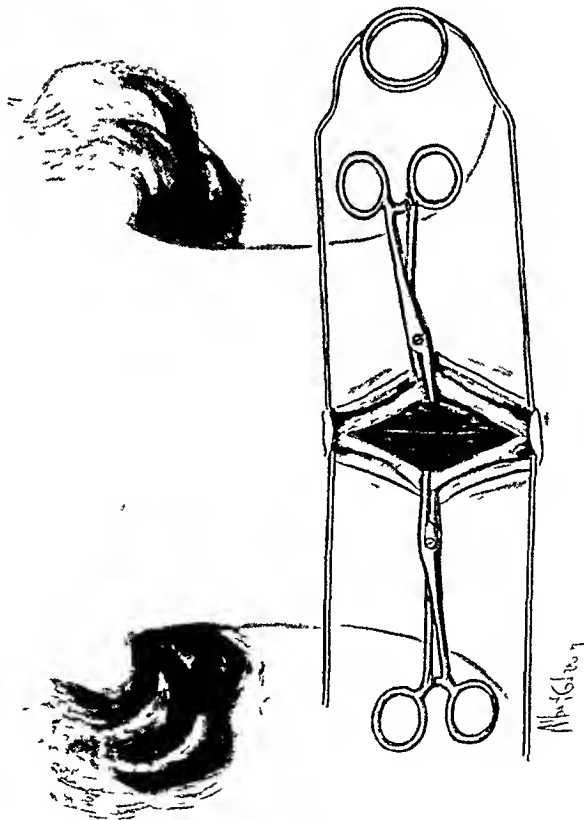


FIG 2.—Showing room allowed with proper retraction. Any further lateral extension of skin incision would be entirely unnecessary

## SIMPLIFIED THYROIDECTOMY

toid muscle to the other. A straight median sagittal sharp knife separation of these sternohyoid and sternothyroid muscles brings one immediately to the anterior capsule of the thyroid. It is seldom necessary to divide the bellies of these muscle coverings. By gentle but thorough retraction, the entire gland may be exposed, especially when the subsequent steps of the operation delivers first one lobe and then the other through these separated muscle walls.

A finely pointed Kelly forceps, probed through the anterior capsule and spread, produces a wide opening through the capsule, which, being bluntly made, starts a well-defined line of cleavage from the underlying thyroid gland. By passing an index finger through this capsular opening and running it quickly over the upper lobe, around the lateral margin well behind and over the lower lobe, the thyroid gland is loosened entirely from its capsular setting. A Lahey clamp is then fastened into the anterior surface of the gland and the lobe in question is rotated out of its bed over the trachea. No pulling, force, or

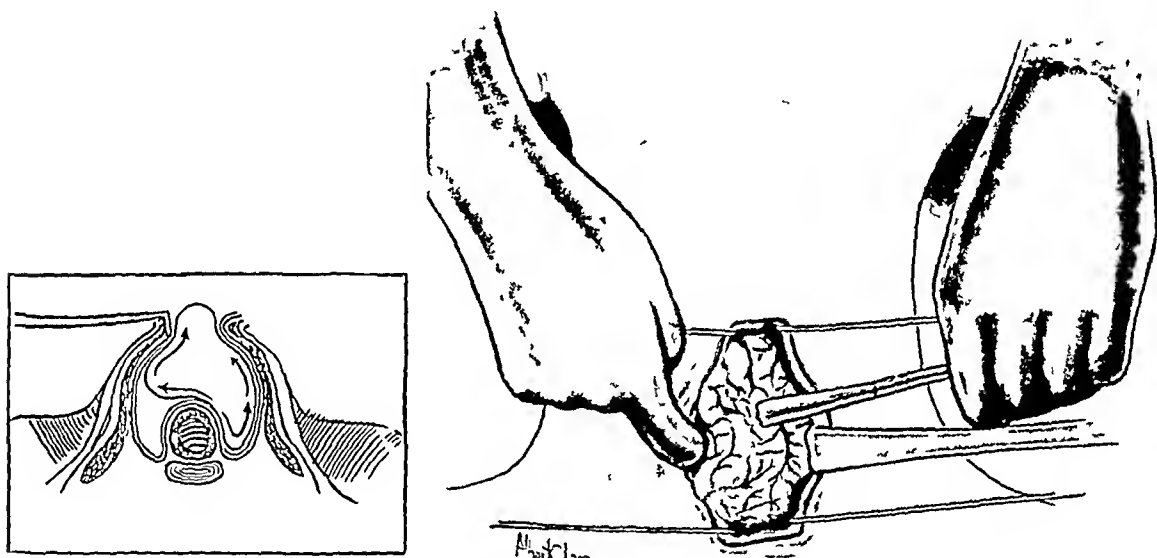


FIG. 4—Blunt finger dissection and rotation of gland allowing complete delivery

traction is necessary. A second Lahey clamp is then attached to the lateral surface of the partially rotated lobe and further and complete rotation is accomplished, which gives a full view of the entire lateral and posterior surfaces of the thyroid. If a substernal gland has been present, this should have been felt and delivered by the probing finger during the blunt dissection and freeing of that portion of the lobe. Here, then, is one lobe of the gland out upon the surface of our operating field, entirely within vision, and free for our every purpose. It is quite a simple problem to know how much of the gland will remain when the knife is passed through its substance. By fastening a line of clamps just posterior to this intended line of excision, and making special effort to fix the possible bleeding points, one is able to make a rapid removal of as much of this lobe as is deemed necessary. The question is not how much shall be removed, but how much shall be left for the patient's subsequent use? One lobe is completely dealt with. Ligatures are applied to all the bleeding

points and the second lobe is delivered and removed in the same manner. The operation is completed with the exception of suturing. If necessary a few sutures are fixed in the gland substance itself to be certain that hæmostasis is complete, and the capsule of the gland is sutured. Two small fine penrose rubber drains are placed, one on either side in the thyroid fossa and the ribbon muscles are joined in the mid-line by interrupted plain No. 1 catgut sutures. The skin and platysma are fixed by Michel skin clips which are to be removed

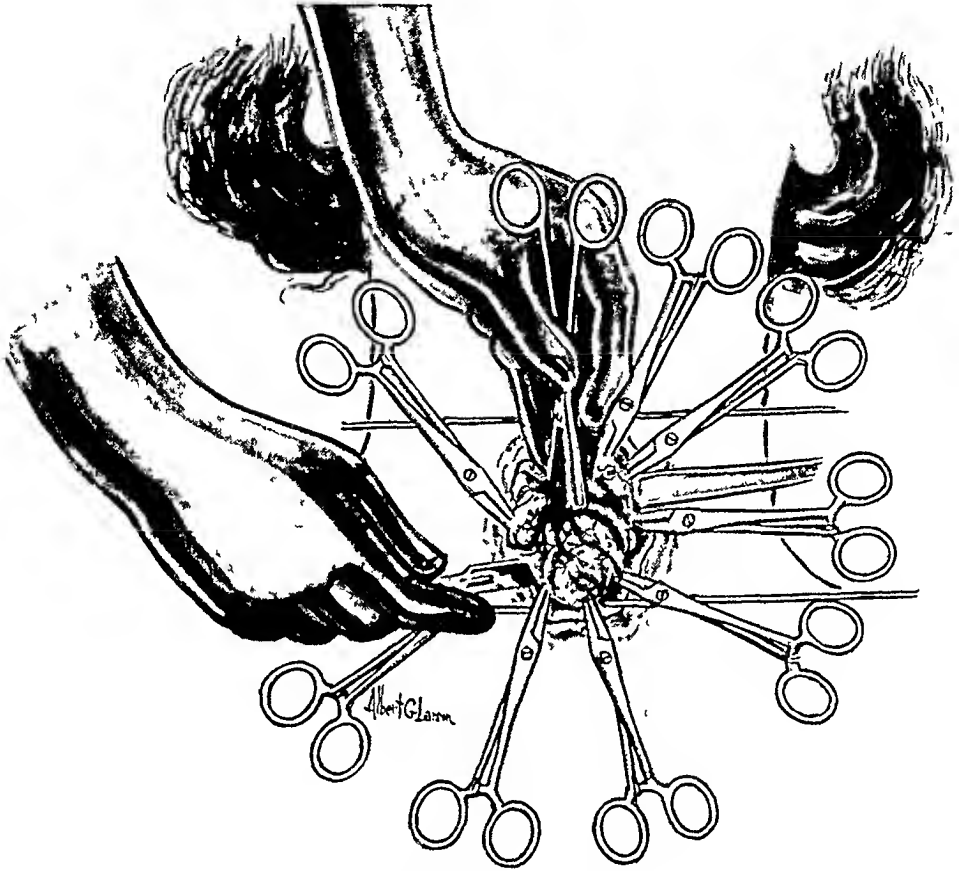


FIG. 5.—Simple excision of rotated and elevated gland. Control of hemorrhage is now entirely on the surface and within vision.

on the second day post-operatively. The drains are to be removed within the first forty-eight hours. The patient is made as comfortable as possible with a neat bandage covering the wound and returned to bed.

*Conclusion*—There is no occasion to attempt removal with the gland deep in the neck. Rotation makes a surface operation out of what many operators have made a deep dissection. Most glands are removed without splitting the muscles. Control of hæmorrhage is simplified. Time required is lessened and thyroid surgery ceases to be such a formidable procedure.

## HOW MUCH THYROID TISSUE SHOULD BE REMOVED IN TOXIC GOITRE?<sup>\*</sup>

BY FRANK H. LAHEY, M.D.

OF BOSTON, MASS.

THE amount of thyroid tissue to be removed in toxic goitre varies quite widely in different individuals and different types of goitre. It is of very great importance that the essential medium be attained in thyroidectomy for toxic goitre between too great removal of thyroid tissue and the production of myxœdema and too little removal and the establishment of persisting hyperthyroidism. It is evident, therefore, that one cannot generalize about the amount of thyroid tissue to remove in terms of proportion of the entire gland. One cannot say that he customarily removes three-fourths, four-fifths, or five-sixths of the entire gland, and be in a sound position.

The attitude which everyone seeks to maintain in patients with hyperthyroidism is to remove enough thyroid tissue to produce a complete and lasting cure of the hyperthyroidism, but to leave enough thyroid tissue so that a myxœdema is not present.

Our experience with toxic goitre has demonstrated conclusively to us that the cure of this condition demands quite radical removals of thyroid tissue. Our experience with myxœdema, spontaneous and post-operative, has likewise taught us that this is an extremely undesirable state, and one that should not be considered lightly. Due to the fact that one can restore the basal metabolism rate to normal so readily with thyroid feeding, and due to the fact that patients so restored to normal basal rates are able to pursue practically all of their previous channels of life, one tends readily to assume the position that a certain amount of myxœdema is inevitable following thyroidectomy, does no particular harm, and should cause one no special concern. Such is not the case in our experience, and we feel strongly that the myxœdematous patients, even with their basal rates brought back and maintained at normal levels, are frequently not quite the same individuals physically and emotionally as they were before the production of the myxœdema. There is, in addition, no doubt, at various times, a variable demand for thyroid secretion in the body which is readily met by the organism's ability to increase or decrease output when the patient's thyroid or a part of it is functioning, but which is not met when the individual is on a fixed dosage of artificial feeding.

We should like to discuss, therefore, the amount of thyroid tissue to be removed in toxic goitre from the three aspects which relate themselves to this situation—the age of the patient, the character of the thyroid tissue to be removed, and the technical question of the removal of the thyroid isthmus.

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<sup>\*</sup>Read before the Southern Surgical Association, December 10, 1931.



First, as to the question of the age of the patient in connection with the amount of thyroid tissue to be removed in toxic goitre. One should have in mind always that the production of myxœdema in children is particularly undesirable, since thyroid secretion plays such a definite part in developmental life and psychic states. In doing subtotal thyroidectomy in children, considerable thyroid tissue should be left behind, and if an error be made, it should be on the side of leaving too much rather than too little thyroid tissue.

In connection with the question of involution of thyroid tissue and its probably lessened activity, it must be realized that the hyperplastic thyroids of children with primary hyperthyroidism involute just as definitely as do those of adults (Fig 1). Just as in adults, so in children involution in the thyroid remnants and its effect upon the amount of thyroid secretion available must be considered in determining how much thyroid tissue to leave

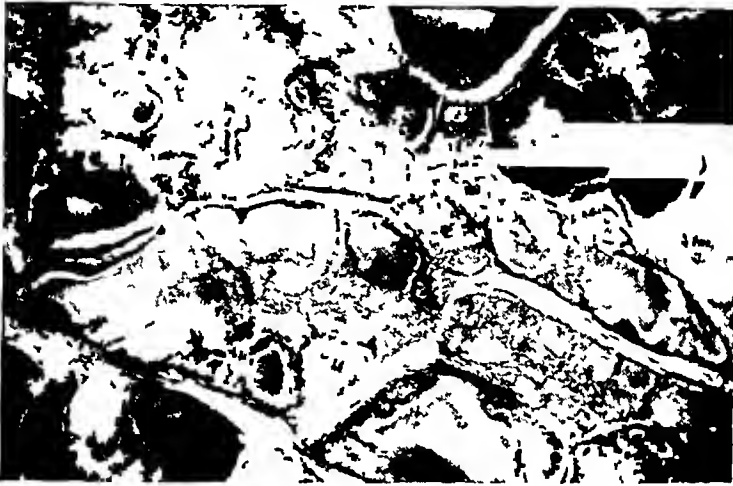


FIG 1—This is a microscopical section of the thyroid in a child of four and one half years operated on for severe primary hyperthyroidism. Note that involution takes place with iodine just as readily as in an adult.

behind. Part of the process of old age is diminished thyroid activity, and in doing subtotal thyroidectomies on people well advanced in years, one should remember that it is probable that the functional capacity of the thyroids of elderly people is not that of younger individuals and so leave behind larger remnants than would remain in younger individuals.

The most important single factor which relates to the question of how much thyroid tissue should be left in subtotal thyroidectomy for toxic goitre is the question of the presence or absence of involution and its degree. Dr R. B. Cattell working in our clinic, in 1925, reported<sup>†</sup> on the effects of iodine feeding upon the histological picture of the hyperplastic thyroid tissue associated with hyperthyroidism. He found that when iodine was administered to patients with hyperthyroidism, definite changes in the form of colloid accumulation, distension of the acini, flattening of the epithelial

<sup>†</sup> The Pathology of Exophthalmic Goitre. Boston Med & Surg Journ., vol cxcii, pp 989-996, 1925.



cells lining the acini, and diminished vascularity usually occurred. This is the state which is termed involution, and one cannot observe the striking changes which occur following the administration of iodine without realizing that advanced involution must certainly be associated with diminished secretory activity, and without realizing, in determining the amount of thyroid tissue to be left behind after partial thyroidectomy, that the question of the presence or absence of involution and also its degree must play a part in settling this point.

Doctor Cattell found that out of all the glands he studied, 90 per cent showed definite involution following the pre-operative administration of iodine, and 10 per cent did not show involution. If one will look at Fig 2, which demonstrates advanced involution, it will be evident that a good-sized remnant of tissue of this type must be left, if one is to avoid the post-operative onset of myxœdema. If, on the other hand, one observes in Fig 3 the uninvoluted thyroid tissue with its limited amount of colloid storage, with its high columnar epithelial lining the acini (Fig 4), with its papillary projections into the acini, it is evident that here is very active thyroid tissue, and if one hopes for a cure of the hyperthyroidism, very radical removals of tissue of this type must be undertaken. It is obvious that if segments of thyroid tissue of the uninvoluted type of a size similar to those of the involuted type be left behind, the hyperthyroidism will not be cured, persisting hyperthyroidism will result, and from these good-sized extremely active remnants will develop the occasionally occurring large post-operative recurrent goitres. It is evident, therefore, that in patients in whom involution of the thyroid tissue with iodine has not taken place, very radical thyroidectomies must be done, and but small thyroid remnants left behind.

Iodine involution or non-involution usually does not occur without clinical evidences of its existence or without gross macroscopical evidences of its presence when a cross-section of the gland is made at the operating table (Fig 5).

Hand in hand with a good iodine involution of the gland during the eight to twelve days of pre-operative preparation with iodine, one usually sees a gain in weight, a drop in pulse rate, a drop in the basal metabolism, and an improvement in the nervous symptoms. This clinical evidence of involution of the gland and improvement with iodine is further confirmed by the gross appearance of such a gland when a cross-section is made of it at the operating table, and it is observed macroscopically. With well-marked involution, the cross-section of the thyroid, due to its accumulated colloid, will show it to be pale and œdematous-like, in contrast to its usual brownish-red and cellular appearance. Due to accumulated colloid, it will be much more firm than the uninvoluted gland. Due to the accumulation of colloid, while it will contain just as many blood-vessels, they will be flattened out by the pressure of the distended acini, and so on section it will appear less vascular. This will indicate good involution, and, in such cases, if good-sized remnants are not left behind, a high percentage of myxœdema will result.

## TISSUE REMOVAL IN TOXIC GOITRE

In those patients in whom iodine involution does not occur during the eight to twelve days pre-operative period of iodine preparation (about 10 per cent of the cases), there will usually not be a gain in weight or drop in pulse rate. The nervous symptoms will not materially diminish, and the basal metabolism will not drop, but at times will rise. On making a cross-section of such an uninvolved gland at the operating table, it will be found to be reddish-brown in color, cellular and vascular in character, and unless, in this type of thyroid tissue, quite radical removals are done, resulting in leaving very small remnants of thyroid tissue, persisting and recurrent hyperthyroidism will ensue.

The occurrence of hyperthyroidism in association with the degenerative

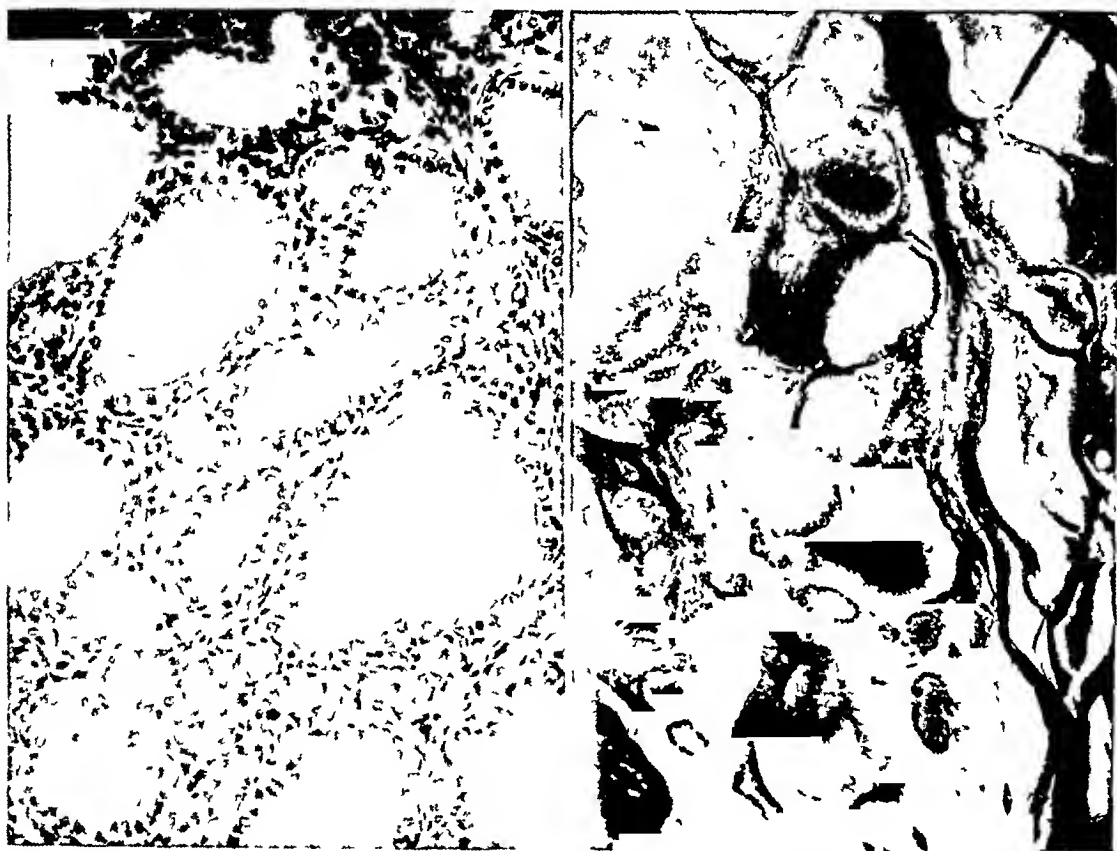


FIG 5

FIG 6

FIG 5—Moderate involution following the administration of iodine for but a short time. Note the accumulation of colloid and the appearance of lessening thyroid activity.

FIG 6—A microscopic section of a multiple colloid adenomatous goitre. Note inactive type of thyroid tissue and how necessary it is not to do too radical removals in thyroids of this character.

processes of hyperinvolution, which are associated with endemic goitre and which have been termed multiple colloid adenomatous goitre, demands that in subtotal thyroidectomies upon thyroid tissue of this type, good-sized remnants must be left if one wishes to avoid the probability of a high percentage of myxoedema. One has but to glance at Fig 6 showing this type of tissue to realize that this is of a poor character, and that if too radical removals are done in such cases many patients will develop post-operative myxoedema.

Up to recent years one heard a good deal about the need of leaving a layer of thyroid tissue of the isthmus over the trachea in subtotal thyroidec-

tomy, in order to prevent reactions in that structure and consequent post-operative tracheitis. While this recommendation was quite general, we believe from our experience that it is not necessary, and, at least in our hands, tends to result in inadequate removals of thyroid tissue in operations particularly for primary hyperthyroidism.

We have now for the last few years purposely bared the trachea and removed all of the isthmus in all thyroidectomies for toxic goitre, in order that we might leave remnants of thyroid tissue only along the sides of the trachea, where they would protect the parathyroids and the recurrent laryngeal nerves. If radical removals of thyroid tissues must be done, and, with the above-mentioned discussion as to tissue type in mind, they not infrequently must be—then it is desirable to remove thyroid tissue only at points where it is not dangerous to do so. We have not observed any greater degree of tracheitis following complete removal of the thyroid isthmus and

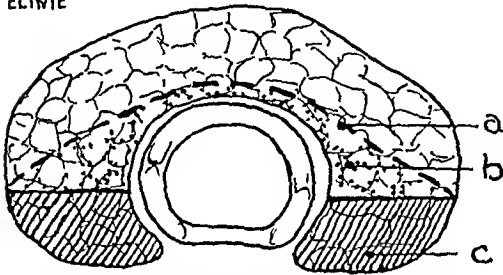
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FIG. 7.—If a segment of thyroid is left over the trachea, only the tissue above line *a* will be removed. If the trachea is bared, it will be possible to leave only the shaded and lined section *c*, doing thus a very radical removal but leaving a safe segment of thyroid tissue over the parathyroids and recurrent laryngeal nerves. When the trachea is bared and only the segments *c* left, then the shaded and dotted area *b* represents the extra amounts of thyroid tissue which can be removed with this procedure as opposed to leaving a segment of tissue over the trachea.

found them extending up to the hyoid bone and amounting to good-sized segments of thyroid tissue.

If one will look at the diagram, Fig. 7, it will be evident that if a section of thyroid is to be left over the trachea, then larger segments of thyroid tissue must be left on either side, and that only by complete removal of the isthmus is it possible to extend the resections laterally into the bodies of the thyroid lobes.

When the isthmus is removed, one may remove with it, as shown in Fig. 7, good-sized segments of the lateral lobes and still leave safe remnants of thyroid tissue over the regions of the parathyroid bodies and the recurrent laryngeal nerves (Figs. 8, 9, 10). This technical step is, we believe from our experience with it, an important feature in one's ability to remove in primary hyperthyroidism sufficient thyroid tissue to bring about a cure, but still to leave enough over the danger areas to prevent injury to the parathyroid bodies and the recurrent laryngeal nerves.

CONCLUSIONS.—Due to the needs for thyroid secretion in development,

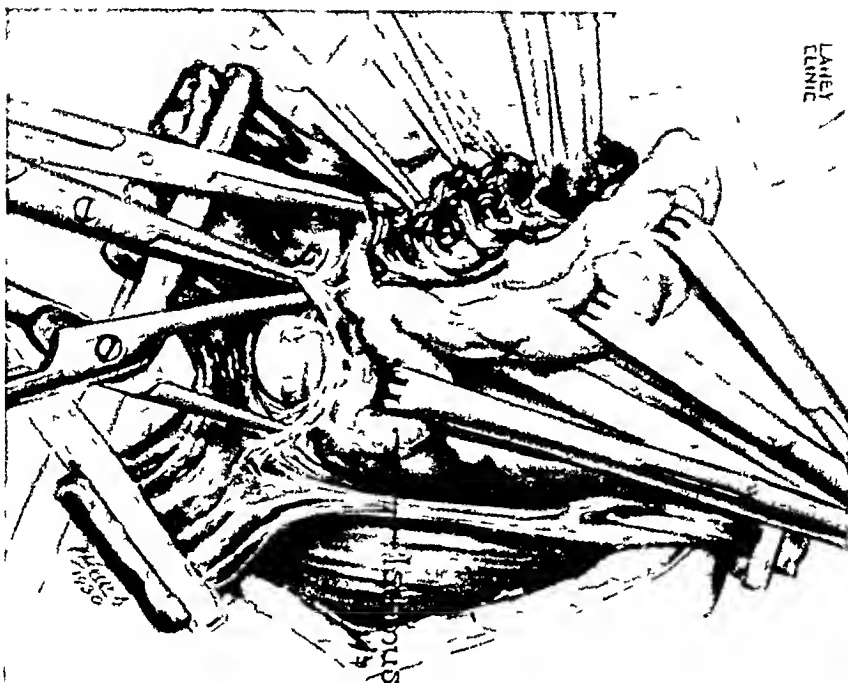


Fig 8—Showing the lateral lobe of the thyroid inverted, turned inward and the posterior segment which is to be left behind marked out with snips and cut. The isthmus has been grasped turned up and is being separated from the trachea by a hemostat (Surgical Clinics North America W B Saunders Co)

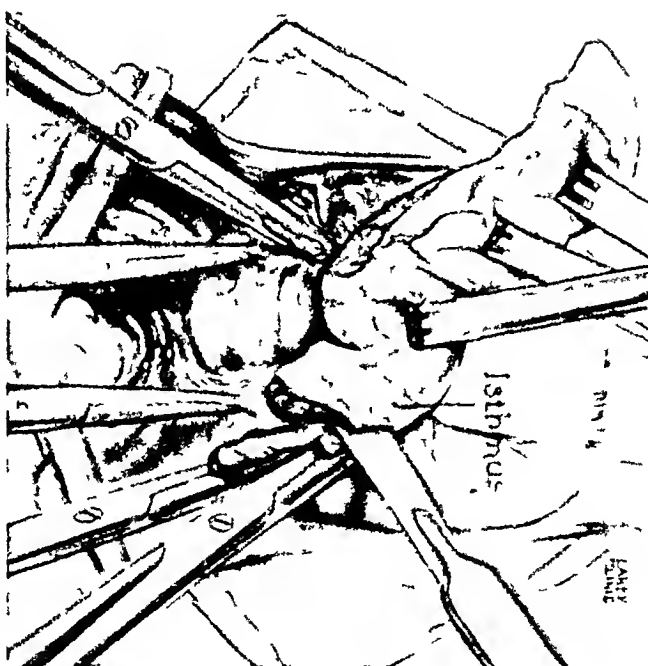


Fig 9—Showing the isthmus separated and turned up from the bared trachea. The attachment of the isthmus to the remaining lobe is being cut away. Note the complete removal of the isthmus and complete baring of the trachea. (Surgical Clinics North America W B Saunders Co)

care must be exercised in thyroidectomy for hyperthyroidism in children that too much thyroid tissue is not removed and myxœdema produced

Due to the relative inactivity of the thyroid in elderly patients, care must be exercised lest radical thyroidectomy produce a high percentage of myxœdema in such patients

Good-sized remnants of thyroid tissue must be left after subtotal thyroidectomy, when, following the pre-operative administration of iodine, marked involution of the gland has occurred

Radical removals of thyroid tissue must be done and but small remnants left in patients with uninvolved thyroids, if one wishes to produce cures in patients with this type of uninvolved thyroid gland

Clinical features indicating the presence or absence of involution are mentioned

Good-sized remnants of thyroid tissue must be left in subtotal thyroidec-



FIG 10—(a)—Showing the remnants of the thyroid left on either side of the trachea with the isthmus completely removed and the trachea bare. Note the remnants of the thyroid turned inward and sutured against the trachea so that all raw surfaces are faced against the trachea. (b)—The lower segments of the thyroid remnants can often be sutured together across the trachea to form a new isthmus and thus restore symmetry in the feminine neck after radical subtotal thyroidectomy (Surgical Clinics North America W B Saunders Co)

tomy for hyperthyroidism associated with hyperinvolution or multiple colloid adenomatous goitre

Complete removal of the isthmus of the thyroid and barring of the trachea do not produce any disturbing amount of post-operative tracheitis. Attempts to leave segments of the thyroid isthmus over the trachea make one tend to leave too large remnants of thyroid tissue, particularly in primary hyperthyroidism. Complete removal of the thyroid isthmus with premeditated barring of the trachea and with extensive removal of thyroid tissue from the lateral lobes of the thyroid leaves a safe amount of thyroid tissue over the recurrent laryngeal nerve and the parathyroid bodies, and makes possible the radical removals of thyroid tissue which are often necessary to bring about lasting cures in hyperthyroidism

# THYROID CRISIS

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ONE of the most serious complications associated with the hyperthyroid state is the condition known as thyroid crisis, or, as is described by others thyroid storms, acute hyperthyroidism, thyroid delirium, or acute thyroidism. That it carries a most substantial risk can best be attested to by the remarks of Lahey<sup>1</sup> when he tells us that in 1927 there were 1,118 operations for thyroid disorders at the Lahey Clinic with six deaths. During this corresponding period there was an equal number of deaths as a result of acute thyroid crisis—as many patients dying from the acute hyperthyroid state as died from 1,118 operations on the thyroid gland.

According to most authorities, the acute thyroid crisis is peculiar to the exophthalmic goitre, and apparently does not occur in the adenomatous goitre with hyperthyroidism unless there is some associated parenchymatous hypertrophy in the remaining gland. It is a well-known fact that the course of exophthalmic goitre is characterized by incomplete remissions and exacerbations and it is during such periods that the condition of crisis is so prone to occur. In our series, however, we have one case in which a large adenomatous goitre was removed at operation, no hyperplastic tissue being found.

Thyroid crisis may occur in individuals in whom there is no suspicion of thyrotoxicosis as described recently by Dixon, and Judd and Dixon. It most frequently occurs, however, in patients known to have hyperthyroidism. It may appear without any apparent inciting cause, or may come as the result of an apparent trifling incident which ordinarily would make no impression on the normal individual. It may appear immediately after operation or several days after surgical intervention.

The majority of crisis cases occur in patients in whom the hyperthyroidism has been present for some time. Either these patients have not sought relief from their hyperthyroidism or they have had only half-hearted treatment on the part of their attending physicians. Hyperthyroidism must not be permitted to go on. Treatment must not be delayed, and if we are to eradicate hyperthyroidism as well as all the complications resulting from hyperthyroidism, our treatment must not be one of watchful waiting. If we are to prevent irreparable myocardial injury, irreparable parenchymatous injury, acute hyperthyroidism with its attendant high mortality, if we are to do away with persistent exophthalmos, we must not procrastinate and treat



our patients with iodine, thyroidectin, digitalis, X-ray, radium, or ultra-violet ray, but must insist on proper surgical intervention as soon as the patient is adequately prepared

Acute hyperthyroidism is frequently ushered in by physical fatigue, by intense psychical stimulation such as fright, anger, or sorrow, by an intercurrent infection such as an acute tonsillitis, acute sinusitis, acute appendicitis or an acute cholecystitis. It may follow a serious emotional stimulation such as a death in the family, the witnessing of a gruesome accident, or it may come on after a minor surgical procedure such as the opening of an infected finger, the opening of an abscess, or injection of a varicose vein.

Unrecognized, potential or latent hyperthyroidism has long been known. It is in these patients that death may be the result following some operative procedure, unless the condition is recognized and proper therapy instituted without delay. Dixon recently reports such a case occurring in a young woman who complained of pain in the right lower quadrant. While being observed in the hospital she had an acute attack, and at operation an inflamed appendix was removed. The immediate post-operative period was without incident, the temperature remaining between 99° and 100°. Without apparent cause the temperature rose to 104.2°, the pulse, which was 80, rose to 160 per minute, and a distinct tremor was noted. Peritonitis, hæmorrhage, and other post-operative complications were ruled out and a diagnosis of impending thyroid crisis was made. Under large doses of compound solution of iodine the entire picture was changed after twenty-four hours. A characteristic exophthalmic goitre was later removed. Had this condition been unrecognized it is safe to say that she probably would have gone into a serious condition. Here we see a case of latent hyperthyroidism which became manifest following the shock of a surgical procedure.

Every hyperthyroid patient is a poor risk when any form of treatment not aimed to relieve the hyperthyroidism is instituted. No evident hyperthyroid patient should be exposed to tonsillectomy until after the thyrotoxicosis has been controlled, or a serious crisis may be the result.

Some years ago one of my colleagues had such an unfortunate case. His patient, a mild case of hyperthyroidism, was referred to him for tonsillectomy because of recurrent attacks of tonsillitis. The attending physician felt that if all foci of infection were eradicated, the thyroidism might be more easily controlled. The operation was a simple procedure, but almost immediately vomiting set in. The pulse became very rapid and diarrhoea very distressing. The patient lapsed into a deep coma, dying in an acute thyroid crisis.

Recently we observed a fatal case of thyroid crisis following the injection of a varicose vein. The patient was markedly hyperthyroid, he also had varicose veins and one varicose ulcer which distressed him greatly. Injection of the veins was refused until after the hyperthyroidism was controlled. The veins in the region of his painful ulcer, however, were injected by another physician. Evidently there was considerable extravasation of the injected

material for he complained of severe pain at the site of injection and within a short period of time was in a severe crisis. Heroic treatment was instituted but to no avail.

Procedures which are life-saving in character, however, such as an operation for an acute appendix, must not be postponed but the patient should be fortified as best he can, immediately before and after the operation to prevent a fulminating hyperthyroidism. In short, any measure unless life-saving in character not aimed at relieving the hyperthyroidism should best be postponed until after thyroidectomy has been performed.

The incidence of thyroid crisis is extremely low, the average man seeing few, if any, in his life's work. It must be said however, that prior to the use of iodine in the treatment of hyperthyroidism, cases of crisis before and especially after operation were more common. In justification to the average man it is only fair to say that he is recognizing hyperthyroidism earlier and sending them to the surgeon sooner, thus preventing the serious thyroid crisis as well as the other complications peculiar to this disease.

Before the days of adequate pre-operative preparation of the patient with iodine, post-operative thyroid crisis was not infrequent. Fortunately, the use of iodine has revolutionized the entire aspect of the surgical treatment of thyrotoxicosis. Where three or four operative procedures (bilateral polar ligations, and two-stage thyroidectomy) were resorted to, frequently attended with severe reactions following each procedure, today by far the greatest per cent of cases are completed in one stage with post-operative reactions reduced to a minimum. Although uncommon, we must not lose sight of the fact that they occur even today and we must be prepared to recognize this condition immediately and institute judicious treatment before the patient becomes serious.

Adequate pre-operative preparation with iodine will in the majority of cases prevent post-operative acute hyperthyroidism. It is a dangerous procedure to put every patient on thirty minims of Lugol's solution daily and feel that the patient is safe against severe reactions. It is likewise unsafe to rely on a single low metabolic rate for, indeed we have often seen highly toxic patients with comparatively low basal rates. Conversely, we have met with patients who in spite of marked clinical improvement under Lugol's solution, have had a rise in their basal rate. It is only through experience and judgment that the optimum time for operation is best ascertained. If we must lay down rules the following should be fulfilled: (1) The weight curve must be on the upward rise, (2) the pulse must nearly approximate, or be within, the normal range, (3) nervousness, apprehension and emotional instability must be adequately controlled, (4) a falling metabolic rate preferably below  $+20$ . The fulfilling of these criteria would constitute the ideal surgical risk which however is only occasionally met. We not infrequently operate on patients with basal rates of over  $+35$  with pulses over 90 but

whose general condition is, nevertheless, sufficiently good to warrant doing a thyroidectomy

The picture of crisis may appear suddenly with extreme violence, or come on gradually with definite premonitory symptoms. As a rule, crisis cases occurring without any definite precipitating factors first show evidence of increasing toxicity such as a rising pulse, increased excitability and lessened emotional control. Injury, infection, an operation, a death in the family, or a severe fright occurring in a hyperthyroid individual may cause an acute crisis with little or no warning. Post-operatively, the picture of crisis may appear immediately or as long as forty-eight to seventy-six hours.

The actual crisis usually manifests itself by an attack of vomiting and diarrhoea, which soon becomes distressing. The pulse climbs rapidly and steadily, often becoming uncountable. The temperature rises to from  $104^{\circ}$  to  $107^{\circ}$ , although exceptional cases have been known in which the temperature remained normal. Restlessness becomes extreme so that the patient is held in bed with considerable effort, often requiring mechanical restraints. The face becomes flushed, and sweating profuse. Talkativeness merges into delirium and may be followed by coma, from which the patient can be aroused only with difficulty. If this condition is permitted to continue, the vomiting and diarrhoea become less frequent. As dehydration occurs the skin and mucous membranes become extremely dry. The pulse continues to rise and auricular fibrillation may set in with a marked pulse deficit. The final picture is one of profound coma terminating in death.

The exact mechanism by which a crisis might be set in motion is not known. Goetsch makes the suggestion that in hyperthyroidism there is an extreme sensitiveness to adrenalin. Crile makes the suggestion that thyroxin sensitizes the tissues to adrenalin. He says "Adrenalin increases hyperthyroidism, hyperthyroidism increases adrenalinism (*i.e.*) hyperthyroidism and adrenalinism co-exist, each augmenting the other." Thus a vicious circle is created. Excessive handling of the hyperplastic tissue at operation, liberating relatively large amounts of thyroxin into the blood-stream, has been suggested to explain post-operative crisis, but, indeed, we have seen cases in which there has been a minimum of handling yet the acute manifestations have occurred. It must be said, however, that a properly prepared patient, a careful rapid one-stage thyroidectomy, and adequate post-operative therapy consisting of iodine from 50 to 120 minims during the first twenty-four hours, plenty of fluids given by mouth, rectum, or, if necessary, subcutaneously or intravenously, plenty of sedatives for the first twenty-four to forty-eight hours, will tend, in the majority of cases, to prevent severe reactions.

Thyroid crisis is a grave emergency. The patient with an impending thyroid crisis, or one already in an active crisis, can well be compared to the patient in an impending or already in a diabetic coma, and if the patient is to remain alive, treatment, often heroic in character, must immediately be insti-

tuted Lahey says "Just as there is an emergency treatment for impending diabetic coma, there should be and is an emergency treatment for the impending thyroid crisis "

Our armamentarium in this condition consists for the most part of iodine, fluids, glucose, and morphine Our success with this treatment must depend, however, upon the early recognition of the condition If applied early and in sufficient amounts before full development of the crisis, a happy outcome will be the result in the majority of cases Recognized late, when the patient is in an active crisis, the results are often most disappointing

We have seen patients change, within twenty-four hours, from critically ill individuals, semi-comatose with diarrhoea, vomiting and high temperature, to moderately hyperthyroid patients after the administration of 120 minims of compound solution of iodine Iodine is by far the most valuable and most effective measure we have at our command One further statement regarding iodine in this connection must be made It is a well-known fact that once a patient has improved under iodine therapy, it seldom can be repeated with the same degree of efficiency, unless the iodine has been withdrawn for a long period Even after withholding iodine for a considerable period, it is doubtful whether the same striking benefit can again be obtained when it is resumed Since every hyperthyroid patient is a potential crisis case, are we not robbing such a patient of perhaps a life-saving measure in the event a crisis occurs by continuing iodine over a long period of time instead of using it as a measure preparatory for operation?

Just how we will administer the iodine will depend upon the patient's condition If the state of affairs is recognized early, before the onset of vomiting, iodine may be given by mouth, in doses of twenty to thirty minims, every three or four hours until 100 to 150 minims are given, or until a decided clinical improvement has occurred Should there be vomiting without diarrhoea, Lugol's solution can be given by rectum If vomiting and diarrhoea are both present, then we must resort to either the intravenous route, or give it under the skin By hypodermoclysis from thirty to fifty minims of Lugol's solution may be given in 1,000 to 1,500 cubic centimetres of saline solution and repeated when necessary Should the intravenous route be found necessary, 0.5 gram (7.5 grains) of sodium iodide may be given together with saline or saline and glucose In the semi-comatose patient iodine may be given by stomach tube and repeated as often as necessary

In addition to iodine these patients must have sufficient fluids and fuel Because of the vomiting, diarrhoea, profuse sweating and the curtailment of fluids dehydration becomes a serious factor and must be replenished if the toxæmia is to be combated Because of the rapid burning of glycogen in hyperthyroidism, but most especially in the crisis, there is a depletion of the glycogen reserve of the body which must be replaced From 75 to 100 grams of glucose in 1,000 cubic centimetres of normal salt are given into the bloodstream very slowly, and repeated every five or six hours until the general condition has decidedly improved

Because of the extreme restlessness sedatives must be given and repeated as often as necessary. Hyperthyroid patients need larger doses of morphine than do other acutely ill patients, and should be given in quarter-grain doses repeated as often as is necessary. Paraldehyde and sodium amytal given intravenously have been suggested as means of controlling the restlessness.

Ice packs have been advocated when the temperature reaches  $103^{\circ}$  and are said to relieve restlessness, lower the temperature and pulse, and induce sleep.

Operative procedures upon patients who have recovered from a crisis must be done with extreme caution. Some goitre surgeons feel that such patients can be adequately prepared within a short period of time. These patients have passed through a profound shock and stand surgery poorly. They can well be compared to a badly injured individual in shock, and no surgeon would attempt any radical procedure until the shock is adequately controlled. Instead of the ten days' preparation following a crisis, as is advocated by some goitre surgeons, we feel that such patients must have a much longer period of preparedness, as long as three to six weeks after the acute phase has passed, and, if necessary, longer. Then we can safely do a one-stage operation with comparative ease and safety.

*Summary*—(1) Thyroid crisis is one of the most serious complications of hyperthyroidism.

(2) As a rule this condition occurs in the primary toxic, or exophthalmic goitre.

(3) Thyroid crisis usually occurs in patients known to have hyperthyroidism but in whom no treatment has been sought or in whom inadequate treatment has been instituted.

(4) Thyroid crisis may occur in individuals in whom there is no suspicion of thyrotoxicosis.

(5) A crisis may come on immediately after operation or several days later.

(6) Acute hyperthyroidism may be ushered in by physical fatigue, by psychical stimulation, as a result of an intercurrent infection or appear after some surgical condition often trivial.

(7) Measures not aimed to relieve the hyperthyroidism should be postponed until after thyroidectomy has been performed.

(8) Adequate pre-operative therapy will in the majority of cases prevent post-operative acute thyroidism.

(9) The picture of crisis may appear suddenly with no premonitory manifestations or make its appearance slowly with definite symptoms.

(10) The mechanism whereby a crisis is set into motion is not known.

(11) The condition must be recognized early and proper therapy instituted immediately or death will frequently result.

(12) Treatment consists of iodine, fluids, glucose, and morphine.

(13) After recovery from a crisis, surgical intervention should be done with caution waiting sufficiently long enough to get the patient in proper physical condition.

## THYROID CRISIS

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# MALIGNANT TUMORS AND TUMOR-LIKE GROWTHS OF THE THYMIC REGION

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IN THE Pathological Laboratories of Bellevue Hospital, I have had occasion to study a series of twenty-five malignant tumors or tumor-like growths of the thymic region occurring among approximately 17,000 autopsies, an incidence of 0.14 per cent. This, I believe, is the only large group of cases of this sort to be recorded by a single observer, the literature consisting practically exclusively of scattered contributions. Of the latter, Rubaschow<sup>1</sup> collected a series of forty-four examples of sarcoma, thirty-three of which were described as of the lymphocytic type, together with five cases which were designated either as epithelioma or as "cancer medullare." The twenty-five growths studied at Bellevue Hospital were interpreted as originating in the thymus or its remains—a conception based on the fact that all of them occupied the position normally assigned to the thymus, that all of them were solid growths, that all of them presented a histology in keeping with tumors arising from the several types of tissue that enter into the structure of the thymus, that in all of them no growth was encountered in any other part of the body that could be construed as primary, that all of them pursued a noticeably similar scheme of invasion and destruction of adjacent tissues, that many of them feigned the shape of the thymus, including the presence of a notch at its lower or pericardial end, and, finally, that no more logical source of origin could be determined among the contents of the anterior mediastinum than that of the thymus or its debris.

Of the twenty-five Bellevue Hospital cases, eight were of the group of the so-called peritheliomata, nine were lymphosarcomata, five were examples of Hodgkin's disease, two were epitheliomata and one was a spindle-cell sarcoma arising, most probably, from the connective-tissue framework of the thymus. In this paper I have followed the older nomenclature of tumors, bad as it is. By usage it has acquired meaning. I have avoided the newer designations, such, for example, as "thymoma," as the further inappropriate use of language. "Thymoma" means "tumor of the thymus," using the word, tumor, in the sense of an autonomous new growth and not merely as a swelling. Any tumor of the thymus, it follows, is a "thymoma"—whether it be epithelioma, spindle-cell sarcoma, lymphosarcoma, perithelioma, or what-not. "Thymoma" is oftenest applied, however, to lymphosarcoma of the thymus. The discrimination is obviously misleading, since the designation in question does not provide for the inclusion of tumors of the thymus other than lymphosarcomata. It is difficult to understand why one should use "thymoma" as a designation for lymphosarcoma of the thymus, while retain-

ing the appellation "lymphosarcoma" for tumors of identical nature in other parts of the body. As yet, so far as I am aware, no such word as "intestinoma" has been coined for lymphosarcoma of the intestine, nor "gastinoma" for lymphosarcoma of the stomach. The practice of naming tumors after the organs in which they arise is a philologic desecration. Thus, "hypernephroma" is meaningless except as the designation for a tumor somewhere "above" the kidney. "Thymoma," therefore, is a variety of hypernephroma, since the thymus, in the animal of erect posture, is "above" the kidney—a *reductio ad absurdum*. "Hepatoma" conveys no conception of the cell derivation of the several tumors of the liver. "Ovarionoma" does not serve to clarify our knowledge of the cell origin of tumors of the ovary. And so on through that gamut of neoplasms where the suffix, *oma*, is arbitrarily attached to the name of a viscus to indicate the origin in it of a particular variety of new growth irrespective of the patonymic rights of other tumors of different cell genesis arising in the same organ.

For purposes of this presentation, the Bellevue Hospital cases have been assembled in such manner as to attempt the portrayal of thymic tumors or tumor-like formations as a composite which, although made up of lesions of divergent histology, is nevertheless attended by methods of growth behavior that are often strikingly alike. Thymic lesions of the sort here described are susceptible of diagnosis during life, although, as a rule, only late in their course. Even in these circumstances appropriate treatment, such as X-ray therapy, may mitigate the symptoms incident to increased intrathoracic pressure. In others it may provide alleviation over such an extended period as to constitute what is familiarly characterized as a clinical cure. With the advance of thoracic surgery, it is conceivable that some of the tumors under discussion might be approached from the operative standpoint, since wider knowledge of their existence may lead to the application of diagnostic methods aimed at their earlier detection. In any event, an understanding of the diversified pathology of thymic growths assists one to apply with greater assurance those remedial measures which are known to afford relief in certain forms of growth and, conversely, more intelligently to appraise the reactions of a patient under treatment for a type of growth that is known successfully to resist all methods of therapeutic restraint. In the first group I refer particularly to the lymphosarcomata and Hodgkin's disease, in the treatment of which mitigation of the distressful symptoms of increased intrathoracic pressure is not uncommonly achieved. In the second group I refer to such growths as the epitheliomata, where the outlook is not any too hopeful, and to such ruthless tumors as the peritheliomata, where treatment as now practiced is futile.

In order to formulate an intelligent conception of the origin and behavior of malignant tumors and tumor-like growths of the thymus and its remains, it is necessary to appreciate certain fundamental facts having to do with the embryogenesis and histologic structure of the thymus itself. Investigators are agreed that Hassall's corpuscles and the reticulum cells from



which they spring are of epithelial origin. The derivation of the chief elements of the organ, namely, the small cells, has been the subject of debate. Maximow<sup>2</sup> believed that, early in the process of development, the thymus is invaded by mesenchymal elements which differentiate into lymphocytes and that these accumulate in such numbers as to lend to the organ the appearance of a lymphocytic structure. Maximow's belief in the lymphocytic nature of the small cells is opposed by Stohr<sup>3</sup> and others, but is shared by Hammar,<sup>4</sup> Schaffer<sup>5</sup> and Pappenheimer.<sup>6</sup> The latter has described, in the small cells of the thymus, granulae which are identical with those in the lymphocytes of the blood. As a corollary, he has demonstrated that in clotted plasma cultures there is a difference in the behavior of the two types of cells in the thymus—



FIG 1—Epithelioma of thymus showing infiltration of anterior margin of left lung  
This is the same growth which is shown photomicrographically in Figs 3 and 4

a fact which militates against the acceptance of the view that both of them are of epithelial origin. Furthermore, the conception of the small thymic cell as a lymphocyte is in consonance with our knowledge of the pathology of the thymus, especially of certain tumors which spring from it or from its remains, notably the lymphosarcomata. In addition, the histology of the fully developed thymus affords evidence, not only that its origin is to be traced to two separate sources, but that it is related to the lymph-nodes. Thus, the cortex of the thymus is composed of densely packed cells which are structurally identical with the lymphoid elements of the lymph-nodes and with the cells of the lymphoid follicles in the spleen, the individual cell collections in the cortex being separated from one another by a system of

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vascularized connective-tissue septa. In the medulla the same small cells are present, but are more loosely packed and occur in lesser numbers, while in the midst of them and standing out in contrast are the relatively large epithelial whorls known as Hassall's corpuscles, together with a delicate epithelial reticulum.

From each of the histologic structures enumerated, a particular sort of malignant tumor is capable of arising—epithelioma from the epithelial reticulum and Hassall's corpuscles, lymphosarcoma from the lymphocytic elements, from the blood-vessels that variety of malignant growth known as perithelioma or as perithelial sarcoma, the histologic unit of which is a small vessel surrounded by a mantle of tumor cells, the latter probably springing from the connective tissue of the vascular wall, and spindle-cell sarcoma from the supporting connective tissue. Finally, since the thymus is a constituent of the lymphoid system, it is not surprising to find that its residua are capable of those transformations which constitute Hodgkin's disease.

### THE PERITHELIOMATA

**CASE I**—Male, aged fifty, admitted March 1, 1927, died March 5, 1927. Two months before admission, the patient stated, he had "caught cold," followed by persistent cough, which was made worse by lying down, and by spitting of blood. He complained also of precordial pain, palpitation of the heart on exertion, and of dyspnoea amounting finally to orthopnoea. At the time of admission the patient was cyanotic, breathing was rapid and forced, the superficial veins over the upper chest wall, both in front and behind, were greatly dilated. Physical examination revealed a hard swelling above the right clavicle. Percussion showed marked dullness over the manubrium and to the right as low as the level of the second rib. Fluoroscopic examination revealed a large mass in the upper and anterior mediastinum. Death occurred about nine weeks after the onset of symptoms.

*Autopsy*—On opening the chest, an enormous tumor came into view occupying the position of the thymus gland. The tumor, which was about the size of a grapefruit, was closely adherent to all the structures at the base of the heart and extended into the neck as far as the thyroid gland, which it invaded. On the right side it infiltrated and replaced practically the whole of the upper lobe of the right lung, in a downward direction it penetrated directly into the pericardial sac. The aorta and pulmonary artery were almost entirely surrounded. The right bronchus was completely enclosed and its lumen was greatly narrowed. The surface of the right kidney was studded with small, white plaques which varied in size from 2 to 5 millimetres. On section, these extended through the cortex into the medulla. Both adrenals were markedly enlarged and infiltrated by tumor growth.

*Histology*—Microscopic examination shows the presence of a richly cellular tumor made up of a ground-work of rather poorly vascularized fibrous connective tissue, imbedded in which are islands of small, richly chromatic, spindle-shaped tumor cells arranged sometimes in long, slit-like apertures, but oftenest in the form of rounded or oval or elongated islands of different sizes. Throughout the tumor are numerous congregations of spindle-shaped cells arranged radiately to the walls of small blood-vessels. These radiate cell formations soon lose their individuality, however, and grow diffusely as collections of spindle-shaped cells with no definite arrangement.

**CASE II**—Male, aged fifty-five, admitted June 23, 1925, died July 13, 1925. Four months before admission, the patient suffered an attack of "grippe" followed by persistent cough and spitting of blood, amounting sometimes to a half-pint. During the

three weeks previous to admission, he became increasingly short of breath on exertion and could not walk up one flight of stairs without resting, he also complained of difficulty in swallowing. On admission, fluoroscopic examination showed a non-pulsating mass in the anterior and upper mediastinum. The heart and trachea were displaced to the left. Death occurred four months and three weeks after the onset of symptoms.

*Autopsy*—In the upper and anterior mediastinum was a large tumor which surrounded and was closely adherent to the oesophagus, trachea, the main branches of the left bronchus, and the aorta. The growth invaded the oesophagus, forming a small



FIG. 2.—The heart and pericardium in a case of thymic Hodgkin's disease showing almost complete nodular replacement of both auricles and of the upper portion of the right ventricle, together with infiltration of the parietal pericardium.

cauliflower-like projection into its lumen for a distance of about 5 centimetres. The tumor invaded the left main bronchus and several of the smaller bronchi and replaced the lower third of the left lung, which was firmly attached to the diaphragm below, the left chest wall laterally and posteriorly, and to the pericardium antero-medially. All the lymph-nodes at the hilus of the left lung were large and were replaced by grayish-white tumor tissue. Portions of the pleura, which were removed with the lower lobe of the left lung, were greatly thickened and presented much the same naked-eye appearances as that of the growth in the mediastinum. The liver was enlarged and studded with nodules which were sharply circumscribed, grayish-white in color,

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some of them centrally softened. The largest of these nodules measured from 2 to 3 centimetres in diameter. A number of metastatic deposits were present throughout the mesentery, the larger ones measuring about  $\frac{1}{2}$  centimetre in diameter.

*Histology*—At numerous intervals are collections of spindle-shaped tumor cells arranged radiately to the walls of small blood-vessels. The radiate formation is soon lost, however, and the spindle-shaped cells grow diffusely and arrange themselves in slit-like crevices or as islands of variable size and shape.

CASE III—Male, aged fifty-four, admitted November 6, 1929, died December 29, 1929. Three months before admission, the patient began to complain of shortness of breath amounting at times to orthopnea and of difficulty in swallowing both solids and liquids. At about the same time his feet began to swell. The chest was tapped on three different occasions and a total of 4,500 cubic centimetres of fluid was withdrawn. On admission to Bellevue Hospital, the patient's face was cyanotic. The veins of the anterior chest wall were engorged and tortuous. The face and neck were

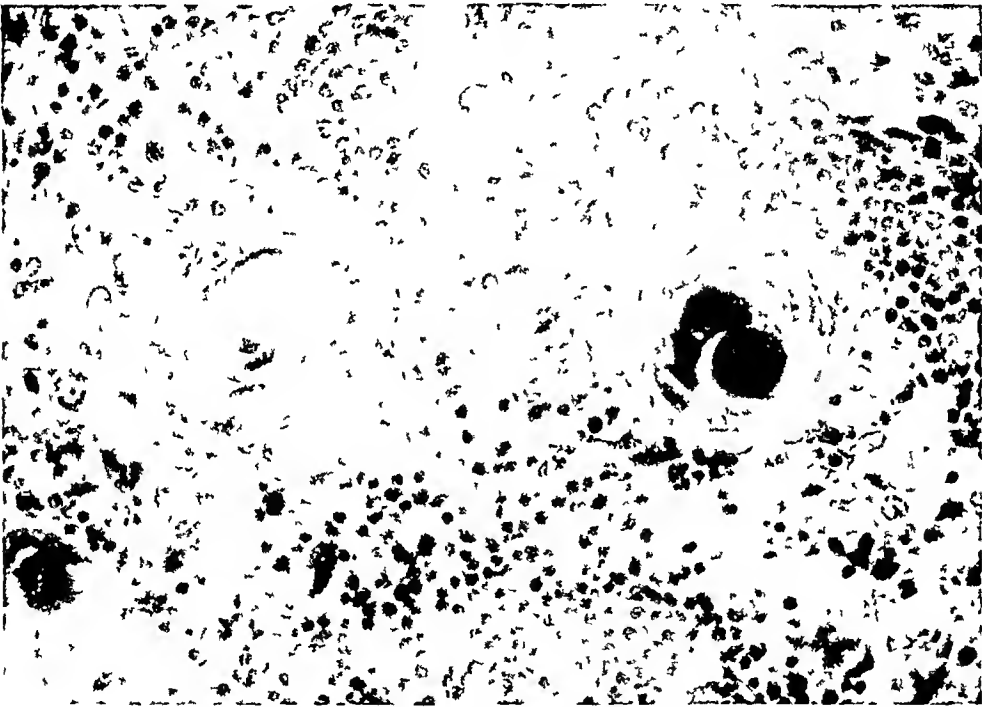


FIG. 3.—Epithelioma of the thymus showing in sections from the main growth small numbers of lymphocytes among which are to be seen large, clear, sharply defined epithelial reticulum cells undergoing keratinization to form Hassall's corpuscles.

oedematous and the right side of the chest showed signs of fluid. The heart was displaced to the left. Thoracentesis was done on two occasions and released a total of 2,500 cubic centimetres of blood-stained fluid. The patient's condition became steadily worse, dyspnea and cyanosis were more marked, he was unable to speak above a whisper, there was marked oedema of the face, arms and legs and recurring hydrothorax and ascites. Death occurred five months after the onset of pressure symptoms.

*Autopsy*—On inspection, the body showed oedema of the face, neck and upper extremities, and the chest and arms presented large distended, tortuous veins. On removing the sternum, a mass was present in the upper anterior mediastinum that assumed the shape of the thymus. The mass insinuated itself around the structures at the base of the heart and invaded the superior vena cava and the innominate and right jugular veins. It extended into the substance of the right lung beside the bronchus, pressing upon and occluding the smaller bronchi so that the lung tissue beyond was atelectatic. The right pleural cavity contained 2,900 cubic centimetres of blood-tinged

fluid On opening the pericardium, about 1,500 cubic centimetres of blood-stained fluid were present The mass invaded the pericardial sac in the region of the superior vena cava The parietal pleura of the right chest was 0.3 centimetres in thickness and was of the consistence of leather The visceral pleura was likewise directly invaded and thickened by the infiltration of tumor tissue The left lobe of the thyroid was nodular and, on section, showed a sharply circumscribed, rounded deposit which measured 5.5 centimetres in length, 3.5 centimetres in breadth and 2.5 centimetres in thickness The medulla of the right adrenal presented a nodule 2.5 centimetres in diameter

*Histology*—Microscopic examination shows a richly cellular tumor, the unit of which is a small blood-vessel arranged around which, radiately to the long axis, is a mantling of tumor cells, terminating suddenly in a broad area of necrosis This formation is maintained throughout the greater part of the original growth and its metastatic deposits, but in other places the vascular unit is lost and the tumor grows as islands of spindle-shaped cells lying in a stroma of connective tissue

CASE IV—Male, aged fifty-three, admitted July 17, 1929, died September 16, 1929 Six months before admission, the patient began to suffer from a cough, which came on in spells and was sometimes accompanied by a sense of choking and occurred more frequently at night On admission to the hospital, the patient was noticeably dyspnoeic and suffered from frequent attacks of cough of the "brassy" type The face was cyanotic and the superficial veins of both upper extremities and of the chest and abdomen were dilated Several enlarged lymph-nodes were felt in the supraclavicular regions The right chest showed signs of fluid and there was brawny œdema of the right arm Shortly after admission, the right chest was tapped on three occasions, releasing a total of 2,800 cubic centimetres of slightly cloudy, yellowish fluid Death occurred eight months after the onset of signs of intrathoracic pressure

*Autopsy*—On opening the chest, a large mass came into view in the superior and anterior mediastinum that encircled the great vessels at the base of the heart and the trachea, compressing the upper lobe of the right lung The superior vena cava was almost completely occluded by compression from the tumor The growth was roughly spherical in outline and measured 9 centimetres in diameter It penetrated the lung in the line of the right main bronchus, which was narrowed to about one-third its normal diameter, the walls of the bronchus being infiltrated by tumor tissue In the pancreas were a half-dozen nodular masses, the largest measuring about 4 centimetres in diameter

*Histology*—Microscopic examination shows the presence of a cellular tumor composed of a fibrous framework lying in which are innumerable large or small, oval or rounded islands of rightly chromatic spindle-shaped cells, most of which are growing diffusely, others arranged radiately to the long axis of the lumina of small blood-vessels

CASE V—Male, aged fifty-four, admitted July 29, 1929, died August 11, 1929 In June, 1928, the patient commenced to suffer from shortness of breath, which continued for a period of about one year and became gradually more troublesome At the time of admission to the hospital, he complained of difficulty in breathing and of pain in the sacral region Physical examination revealed orthopnoea, cyanosis of the face, dilatation of the superficial veins over the anterior thoracic and abdominal walls, the heart was displaced to the left, the right arm was œdematous, the liver was palpable 6 centimetres below the right costal margin and 9 centimetres below the xiphoid Death occurred one year and six weeks after the onset of dyspnoea

*Autopsy*—The upper anterior mediastinum was completely replaced by a mass about the size of a small grapefruit This mass extended superiorly to the suprasternal notch and inferiorly to the base of the heart where it penetrated the pericardium in its upper and posterior aspect in the form of a solitary nodule measuring 5 centimetres in diameter On the right side the growth invaded and destroyed the anterior half of the upper lobe of the corresponding lung On the left the mass was limited by the parietal pleura Anteriorly it lay immediately beneath the sternum and ribs, to both

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of which it was adherent. Posteriorly it insinuated itself around the structures at the base of the heart and attached itself to the trachea, which it compressed. The liver was extremely large, weighing 5,500 grams. It was riddled by nodules varying in size from a few millimetres to about 8 centimetres, many of them showing central umbilication. The liver pushed up the diaphragm on the right side and obliterated the lower portion of the corresponding pleural cavity, the upper portion having been similarly obliterated by compression and invasion of the upper lobe of the lung from the tumor in the thymic region. No lymph-node enlargements were observed in any part of the body. The body of the fourth lumbar vertebra was almost completely replaced by a large white tumor nodule which projected itself beneath but did not penetrate the overlying periosteum.

*Histology*—Microscopic examination shows the presence of a growth made up of innumerable blood-vessels arranged radiately to the long axis of which are collections of small, densely chromatic, spindle-shaped cells. In other places the tumor cells

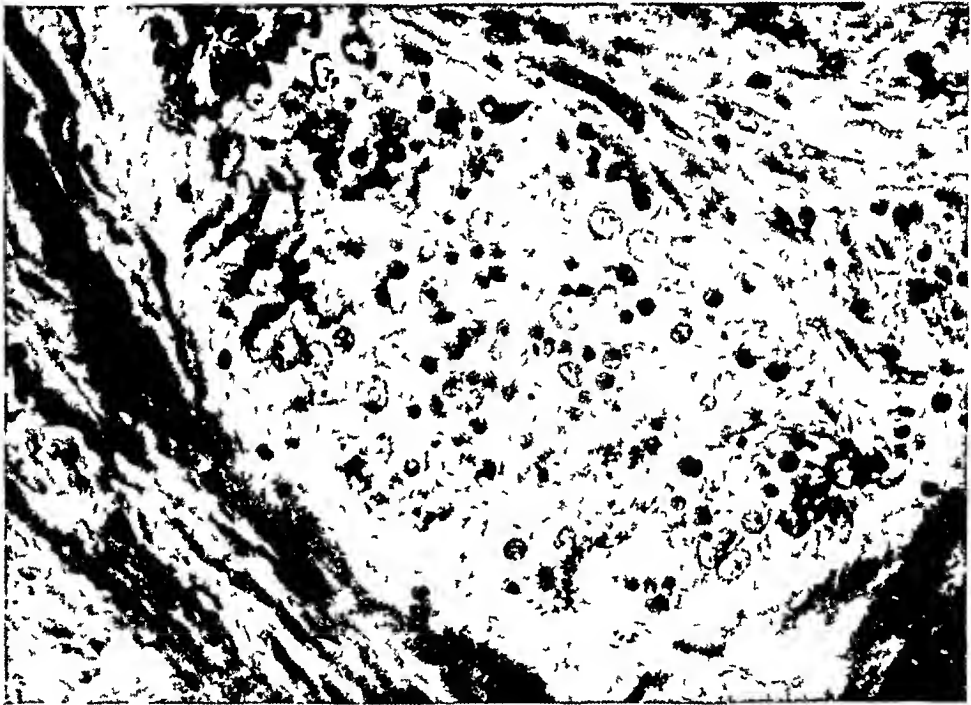


FIG. 4—The same epithelioma as in Fig. 3, showing, in sections taken from the infiltrated lung, a few lymphocytes and considerable numbers of large, clear epithelial reticulum cells and absence of Hassall's corpuscles.

grow diffusely and are arranged in the form of large and small islands or as broad, intercommunicating, plexiform bands.

CASE VI—Male, aged forty-one, admitted June 7, 1922, died September 14, 1922. The patient stated that, for a year before admission, he had suffered from a number of fainting spells preceded by pain beneath the sternum and palpitation of the heart. Otherwise there was nothing of interest in the clinical history, except for the fact that an X-ray picture, taken six months after the onset of symptoms, disclosed a new growth in the mediastinum.

*Autopsy*—On lifting the sternum, an enormous mass came into view, occupying the anterior and superior mediastinum. The mass laterally was bounded by, but not attached to, the lungs. The upper end lay at the level of the suprasternal notch. The tumor was closely applied around the great vessels at the base of the heart, surrounding the aorta, the pulmonary artery, the great veins, the first part of the bronchi, and covering the anterior portion of the trachea. The growth extended downward over the upper half of the pericardium, which, however, it did not infiltrate. The lymph-nodes at the root of the lung were large, hard, and on section appeared to be infiltrated.

by tumor growth. The right lung contained a deposit in the middle of the upper lobe that, on section, measured about  $1\frac{1}{2}$  centimetres in diameter. Above the pancreas was a soft, nodular mass which measured  $7\frac{1}{2}$  by 6 by 5 centimetres and consisted of fused lymph-nodes. These, on section, presented much the same naked-eye changes as that of the original tumor in the thymic region. The liver was greatly enlarged, weighing 5,525 grams. Throughout its substance were innumerable yellowish-white nodules, varying in size from  $\frac{1}{2}$  to 5 centimetres in diameter, many of them projecting above the surface.

*Histology*—Microscopic examination shows a growth the unit of which is a blood-vessel surrounded by rather large, richly chromatic, spindle-shaped cells arranged radiately to the long axis of the vessel lumen and shading off into broad sheets of tumor cells in which few, if any, blood-vessels are visible.

CASE VII—Male, aged fifty-one, admitted August 14, 1923, and died four days later. The patient's complaints at the time of admission were of oedema of the face, legs and hands, cough, shortness of breath, weakness, and rapid loss of weight. He stated that in the preceding three months he had had transient swelling of the face, legs and hands that had become persistent for the past month. Shortness of breath corresponded to these periods of oedema. He had had a cough for many years and this had become increasingly annoying with the advent of oedema. The patient finally became exceedingly weak and for this reason sought entrance to the hospital. Physical examination revealed, in addition to oedema of the face and extremities, that the respiratory movements were markedly diminished on the right side. Shortly after admission, the patient's right chest was tapped and 1,500 cubic centimetres of clear straw-colored fluid withdrawn. This was repeated two days later and 845 cubic centimetres were removed.

*Autopsy*—The body was that of an emaciated male, showing oedema of both legs and of the right upper arm. On opening the chest, a massive whitish tumor came into view in the anterior and superior mediastinum that simulated the shape of the thymus. The growth extended upward into the root of the neck, especially on the right side, and downward to surround the bronchus of the right lung. The large vessels at the base of the heart were buried in the growth, but were not noticeably compressed. The pleura was studded with white nodules, varying in size from 2 millimetres to 5 centimetres, involving, especially, the dome of the diaphragm. In other places these nodules infiltrated the adjacent intercostal muscles. The pericardium was penetrated in its upper aspect and thickly infiltrated with tumor nodules derived directly from the mass in the anterior mediastinum. The lungs showed nothing worthy of note, except for the presence in the right lower lobe of a growth of tumor tissue extending along the walls of the bronchi and gradually thinning out towards the surface of the lung, spreading fan-fashion. The posterior mediastinal lymph-nodes were infiltrated, as were the nodes in the region of the pancreas, while the pancreas itself was occupied by nodular growths of the same type. The liver was enlarged and weighed 3,600 grams. It was diffusely studded with large reddish nodules, many of which were solid and elevated above the level of the capsule, others were umbilicated. The nodules measured on an average of about 3 to 5 centimetres in diameter and were well defined.

*Histology*—Microscopic examination shows the presence of small blood-vessels, many of which are surrounded by a mantle of small, spindle-shaped, richly chromatic cells with scanty cytoplasm, the cells being arranged radiately to the long axis of the vessel. For the greater part, however, the tumor cells are laid down in a fibrous stroma as islands of various shapes and sizes, composed of cells of precisely the same type as those described.

CASE VIII—Female, aged fifty-three, admitted September 23, 1929, died November 7, 1929. The patient stated that she had been in excellent health until six weeks before admission to the hospital, when she suddenly began to experience difficulty in swallowing. She was able to retain fluids until twelve days before admission, when vomiting

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set in and was frequent. At about the same time she began to suffer from a sensation of choking, especially when lying down. Physical examination revealed continuation of cardiac dullness upward to the suprasternal notch and for a distance of about 25 centimetres on either side of the median line beneath the clavicles, together with an area of dullness in the corresponding interscapular region posteriorly. Death occurred three months after the onset of pressure symptoms within the thorax.

*Autopsy*—On lifting the sternum, a mass came into view occupying the upper and anterior mediastinum that measured 10 centimetres in a downward direction and 7 centimetres laterally and simulated the shape of the thymus. The growth extended upward to the base of the neck and downward around the right bronchus and into the corresponding lung, the middle and lower lobes of which were collapsed and atelectatic. The mass was adherent to the aorta, the trachea and the upper end of the œsophagus.

*Histology*—Microscopic examination shows moderate numbers of small vascular channels with a radiate arrangement of spindle-shaped tumor cells, the latter, at the extreme periphery, assuming a distribution circumferential to the lumen of the vessel. In sections taken directly from the tumor proper, atrophic but otherwise well-preserved Hassall's corpuscles were found in considerable numbers.

## THE LYMPHOSARCOMATA

CASE IX—Male, aged twenty-five, admitted April 9, 1914, died April 13, 1914. It was impossible to obtain a satisfactory history, but it was learned of him that, two and a half months before admission, a tumor-like mass appeared below the angle of the left jaw and a month later a similar mass became noticeable on the opposite side. Both gradually increased in size and the patient began to complain of difficulty in breathing that steadily increased. At the time of admission to the hospital, he presented marked orthopnoea and cyanosis of the face. Large, freely movable masses were present on both sides of the neck and the axillary and inguinal lymph-nodes were enlarged. The feet and legs were œdematous.

*Autopsy*—The mediastinum, corresponding to the position normally occupied by the thymus, was filled by a huge tumor. The mass insinuated itself around the great vessels at the base of the heart and posteriorly to include the œsophagus, trachea and bronchi. The upper portion of the œsophagus was compressed and irregularly infiltrated by tumor tissue. The left primary bronchus was similarly infiltrated and almost completely occluded. Likewise, the walls of the superior vena cava were invaded. The growth penetrated the pericardium and both auricles and infiltrated the epicardial fat over the right ventricle. The right tonsil was enlarged to the extent of about 3 centimetres and, beneath the ramus of the left jaw, there was a solitary lymph-node likewise measuring about 3 centimetres in length. Otherwise the cervical nodes were free, as were the inguinal, femoral, retroperitoneal and iliac nodes. The nodes around the pancreas were enlarged to an enormous extent and the pancreas itself was diffusely infiltrated by whitish tumor tissue. In the wall of the small intestine were several nodules which measured about 3 centimetres in diameter. In the lower pole of the right kidney was a nodule measuring 1.5 centimetres in diameter.

*Histology*—Microscopic examination of sections from the growth in the thymic region and from the enlarged lymph-nodes shows a rich aggregation of lymphocytes supported in a moderately cellular framework of connective tissue. Identical foci are found in the heart muscle, kidney, pancreas and the wall of the gut.

CASE X—The patient, male, aged twenty-six, was admitted complaining that three weeks before admission he suddenly experienced difficulty in breathing and became subject to severe cough. Physical examination revealed, in addition to dyspnoea, cyanosis of the finger-tips, œdema of the subcutaneous tissues and ascites.

*Autopsy*—The subcutaneous tissues were universally œdematous. On lifting the sternum, the anterior mediastinum was found to be occupied by a growth which meas-



ured 9 by 13 by 10 centimetres and which conformed in a general way to the shape of the thymus. The tumor extended downward to the level of the auriculo-ventricular groove and upward to within a short distance of the lower border of the thyroid gland. Laterally it infringed on the root of the left lung and bands of tumor tissue extended along the connective-tissue planes around the larger bronchi for a distance of several centimetres. The substernal, peribronchial, peritracheal and lower cervical nodes were enlarged, discrete, the largest approximating the size of a cherry. The pericardium contained about 200 cubic centimetres of turbid fluid with fibrin flocculi, and both layers were covered with fibrinous exudate. The epicardial fat was diffusely infiltrated by grayish-yellow tissue, similar to that of the growth in the region of the thymus. The walls of both ventricles were enormously thickened and rigid, and were largely replaced by grayish-yellow tumor tissue, only islands of reddish musculature showing through at intervals. The parietal and diaphragmatic pleuræ on the right side measured 0.5 centimetre in thickness and were adherent to the chest wall, pericardium and diaphragm through the medium of infiltrating tumor tissue. The kidneys were



FIG. 5.—Low power photomicrograph from a perithelioma of the thymus, showing the vascular unit of growth with its radiate and circumferential arrangement of spindle shaped tumor cells, together with peripheral zones of necrosis.

massively enlarged and weighed, together, 1,300 grams. Each measured 17 by 8.5 by 8 centimetres. The cortices were unusually broad and grayish in color, standing out in contrast to the dark red pyramids.

*Histology*—Microscopic examination of sections from the mass in the thymic region reveals a markedly cellular growth composed of lymphocytes, the cells in places being closely packed, in other places grouped in islands of various sizes, in still other places presenting a streak-like alignment. In the lymph-nodes the cellular unit is morphologically identical with that in the thymic growth, but the distribution of the cells is diffuse rather than insular or striate. In the heart muscle, incursion of lymphocytes occurs to an amazing extent, almost every individual muscle fibre being separated from its fellow by a dense infiltrate of lymphocytes, the muscle fibres compressed and their striations lost. Sections from the kidney disclose interstitial invasion by lymphocytes in proportions no less prodigious than those encountered in the heart, the infiltration extending from pelvis to cortex, bringing about wide separation of the tubules. Except

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for minute interstitial lymphomatous deposits in the liver, the remaining organs show nothing worthy of note

CASE XI—Male, aged fifty-eight, admitted April 8, 1921, died April 9, 1921. The patient stated that in March, 1918, he noticed a swelling in the right side of the neck that gradually increased in size. In February, 1920, a similar swelling appeared on the left side of the neck. In December, 1920, he began to suffer from shortness of breath, followed by difficulty in swallowing and speaking. At the time of admission, about four months later, physical examination revealed a large mass in the left side of the neck, together with enlargement of the inguinal nodes on both sides and of the axillary nodes on the left side. The left side of the chest bulged markedly and the skin over it was œdematous, the corresponding superficial veins were engorged, and the left arm was œdematous to such an extent as to interfere with motion. There was dullness over the upper half of the left lung anteriorly and posteriorly, and bronchial breathing throughout both lungs. The liver was palpable 3 centimetres below the costal margin. The lower extremities were œdematous.

*Autopsy*—Inspection revealed immense swelling and œdema of the left arm and hand. On both sides of the neck were masses of enlarged lymph-nodes that were firmly attached to the skin and to the underlying structures. On the left side of the neck, behind and at about the middle of the sternocleidomastoid muscle, the skin was eroded, giving rise to an irregularly rounded ulcer which measured 5 centimetres in diameter, the edges sloping, the base reddish and granular. In the lower portion of the left axilla was a solitary mass which lay immediately beneath the skin, was somewhat egg-shaped and measured 6 centimetres in length and 3 centimetres in diameter. It was firmly attached to the skin and was only slightly movable against the deeper structures. The inguinal lymph-nodes on both sides were palpably enlarged. On opening the chest, each pleural cavity was found to be occupied by about 250 cubic centimetres of brownish fluid, while a huge tumor came into view in the region normally occupied by the thymus. The tumor measured 17 by 10 centimetres. Its shape was comparable to that of the normal thymus. The growth, extending downward, infiltrated the pericardium and replaced the muscular structures of the right auricle of the heart. It molded itself around the structures at the base of the heart including the aorta and pulmonary artery, and around the upper part of the œsophagus. Direct extensions from the growth covered the parietal pleura above the apices of the lungs. Near the bifurcation of the trachea, a large nodule projected into the œsophagus, in such manner as to lift the mucosa without, however, producing ulceration. At the bifurcation of the trachea, the larger bronchi were surrounded by tumor tissue. The right bronchus was compressed and its mucosa superficially eroded, while in its walls, particularly posteriorly, were cream-colored islands of tumor tissue. The left bronchus, immediately below the bifurcation, presented five or six cream-colored bands of tumor tissue which ran circumferentially, and replaced the cartilaginous rings for a distance of about 4 centimetres. The mass grew upward into the neck, where the soft tissues were directly and extensively infiltrated, the infiltration extending as far as the level of the lower jaw on both sides and as far backward as the trapezius muscle. Around the abdominal aorta, near its bifurcation, were a dozen or more enlarged lymph-nodes, the largest measuring 4 centimetres in length and 2 centimetres in thickness. In the vicinity of the head of the pancreas were several enlarged nodes, the largest measuring 5 by 3 centimetres. The spleen, which measured 15 by 8 centimetres, was free from indications of tumor growth.

*Histology*—Microscopic examination of the growth in the region of the thymus and in the enlarged lymph-nodes in different parts of the body shows a diffuse overproduction of lymphocytes, arranged in an inconspicuous stroma of connective tissue. The histologic changes in the enlarged spleen are those of chronic passive congestion.

CASE XII—Female, aged thirty-one, admitted November 25, 1925, died December 31, 1925. On admission, the patient complained of dyspnoea which had commenced

suddenly four weeks previously and stated that it was becoming increasingly difficult for her to breathe. She was orthopneic and examination revealed swelling of the right upper extremity and of the corresponding breast. Expansion was absent over the entire right chest. The heart was displaced to the left, the apex resting in the sixth interspace, 16 centimetres from the mid-line. There was no enlargement of the superficial lymph-nodes. The right chest was tapped and 1,480 cubic centimetres of clear fluid were removed. In the course of the next three weeks, the right pleural cavity was tapped on five occasions, yielding a total of 9,000 cubic centimetres. In spite of the removal of fluid, dyspnoea not only continued but became more distressing, and death supervened.

*Autopsy*—On lifting the sternum, an enormous tumor came into view lying in the region of the thymus. The growth, which measured 15 centimetres in length and 8 centimetres in breadth, approximated the shape of the normal thymus. Anteriorly, the tumor was attached to the posterior surface of the sternum, and on the right side, at

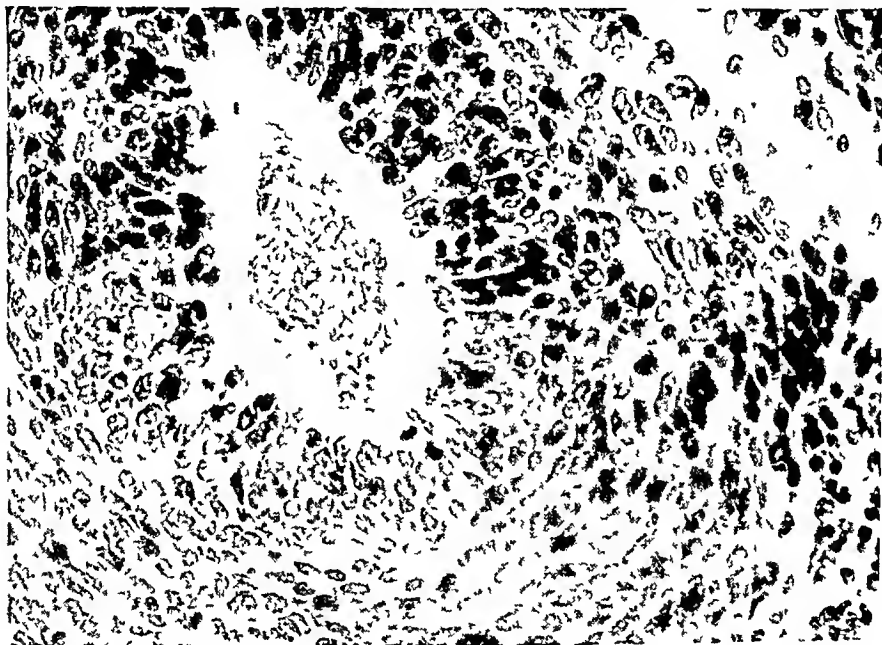


FIG. 6—High power photomicrograph from a perithelioma of the thymus showing a small blood vessel with tumor cells arranged radiately to its long axis and, at the periphery tumor cells in circumferential distribution.

the third and fourth interspaces, it penetrated and replaced the intercostal muscles over a wide area. Posteriorly the growth extended as far as the root of the lung, molding itself around the aorta, trachea and larger bronchi, and the origin of the carotid arteries. Laterally the tumor infiltrated practically the whole of the parietal pleura on the right side, so that the pleura was thickened to the extent of from 3 millimetres to 1 centimetre, the infiltrating neoplasm presenting a smooth or somewhat undulating surface, with here and there nodular formations, the largest of these being about 1 centimetre in diameter at the base. The tumor at its lower extremity presented a notch which was about 3 centimetres in length, thus dividing the growth into two poles—a right and a left. The right pole extended downward over the pericardium and brought about infiltration of the diaphragmatic pleura which was thickened from 1 to 4 centimetres. The left pole sent prolongations from its posterior aspect directly through the upper portion of the pericardium, and the intrapericardial portions of the aorta and the origin of the pulmonary artery were infiltrated with nodular tissue while on the anterior surface of the right auricle, at about its centre, was a solitary nodule fixed to the wall of the

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auricle by a base which measured 1 centimetre in diameter, the mass itself being about  $\frac{1}{2}$  centimetre in height and mushroom shaped. In the epicardium, corresponding roughly to the course of the left coronary artery, were about a dozen pinhead-sized deposits, and in the wall of the left ventricle laterally, midway between apex and base, were two or three nodules, the largest measuring about 1 centimetre in diameter at the base. In an upward direction, the growth extended to the level of the sternum, but did not infiltrate the structures of the neck. Posteriorly, lying just in front of the spinal column and extending downward as low as the pillars of the diaphragm, were numbers of tumor nodules, directly continuous with the main growth. The right lung was compressed, partly by the tumor itself and partly because of the presence in the pleural cavity of a collection of about 750 cubic centimetres of serous fluid. The left pleura was free. The spleen was normal in size and presented a half-dozen small capsular nodules which, on section, extended into its substance for a few millimetres. The left kidney showed two or three small whitish deposits flush with the surface of the organ and extending downward into its substance for a distance of from 3 to 6 millimetres.

*Histology*—Microscopic examination of sections removed from the mass in the thymic region reveals a densely cellular growth of lymphocytes arranged diffusely in an inconspicuous stroma. The same histologic appearance obtains in the enlarged lymph-nodes, and there is identical infiltration of the pleura and the heart muscle.

CASE XIII—A boy, aged seventeen years. On admission, he said that two weeks previously he suddenly became short of breath and was seized by a dull pain in the upper part of the chest, attended by cough and expectoration. On physical examination, both legs were œdematous and the face and neck were cyanotic. On percussion of the chest, there was marked flatness from the clavicles downward. Thoracentesis was followed by the withdrawal of enormous amounts of fluid. The abdomen was similarly distended.

*Autopsy*—On opening the thorax, both pleural cavities were found to contain large quantities of fluid compressing the lungs. Lying in the anterior mediastinum, corresponding to the position of the thymus, was a large, firm mass which extended upward as far as the lower level of the neck and downward in front of the pericardium to the level of the auriculo-ventricular groove. The pericardium was distended by fluid and strewn over both layers was a sheeting of fibrinous exudate. The heart muscle in the upper part of the left ventricle was fleshy in appearance, as if infiltrated by tumor growth. Both kidneys were enormously increased in size, each measuring 15 by 10 by 7 centimetres and weighing, together, 1,040 grams. The retroperitoneal and lower cervical lymph-nodes were moderately enlarged and the bone marrow presented numbers of whitish foci.

*Histology*—Microscopic examination of sections from the growth in the region of the thymus shows diffuse proliferation of lymphocytes with scarcely any discernible supporting framework, but with a liberal supply of small vascular channels. Practically identical changes are present in the lymph-nodes. In the visceral pericardium is a thick layer of densely packed lymphocytes. Among the underlying heart muscle fibres scattered foci of lymphocytes are to be seen. The bone marrow exhibits patchy infiltration of the same sort of cells.

CASE XIV—Male, aged fifty-two, admitted December 12, 1929, died April 13, 1930. The patient stated that five months previously he had noticed some difficulty in speech—that he “had to slow down and not get excited or he could not be understood.” He gradually found it impossible to make himself understood and had to cease work. Shortly before this he experienced difficulty in swallowing which became progressively worse. At about the same time he observed that the lower jaw began to droop and that he had to hold it up with his hand and that the left eyelid sagged. At the time of admission to Bellevue Hospital, the face was expressionless, the neck muscles weak, the patient could not approximate the jaws and it was impossible for him to protrude the tongue. Neurologic examination showed that the right pupil was larger than the left.

The extraocular movements were poor in all directions. There was marked weakness of the fifth and seventh nerves on both sides. The voice was nasal. Otherwise neurologic examination was negative. Death occurred suddenly after an illness of approximately nine months' duration.

*Autopsy*—The autopsy findings were without significance in the present connection except for the presence of a growth in the region normally occupied by the thymus. The growth simulated the shape of the thymus and measured 12.5 by 7.5 by 2.5 centimetres. It was cream colored and, on section, its substance was smooth and homogeneous in appearance and fairly firm in consistence.

*Histology*—Microscopic examination of the growth shows complete obliteration of the normal architecture of the thymus by the diffuse overgrowth of lymphocytes, which are densely packed in an inconspicuous stroma of connective tissue. Among the lymphocytes are numerous vessels, all of them distended by red cells.

#### LEUCEMIC CONVERSION OF THYMIC LYMPHOSARCOMATA

CASE XV—Male, aged thirteen years, admitted July, 1923, died September 13, 1923. The patient complained of weakness and pain in the left side of the chest of two weeks' duration. The onset, he said, was sudden and accompanied by cough and a feeling of fatigue. On admission, the skin and visible mucous membranes were pale and the patient was markedly dyspnoeic. The left side of the chest bulged noticeably and diminished respiratory movements on that side were accounted for by signs of fluid in the corresponding pleural cavity, the heart being displaced to the right. There was slight general lymphadenopathy. The spleen and liver were not palpable. Thoracentesis was performed four times and a total of over 2,000 cubic centimetres of blood-stained fluid was removed from the left chest. About a month after admission, it was noticed that the spleen was palpable 10 centimetres below the costal margin. The patient became progressively weaker and hæmorrhages occurred into the mucous membrane of the uvula and the inside of the cheek. The liver was now at a level with the umbilicus, and the lower edge of the spleen reached the pelvis. Ecchymosis occurred in the left pectoral region, and purpuric spots appeared round the joints of the elbows, wrists, ankles and knees. On admission, the white blood cells numbered 22,000, of which 50 per cent were polynuclear neutrophils, 46 per cent lymphocytes, and 4 per cent mononuclears. The blood count on July 26 showed an increase of lymphocytes to 61 per cent, and on September 7 the white cells numbered 97,600 and, of them, 98 per cent were lymphocytes.

*Autopsy*—The body was that of an emaciated, very anæmic boy, in whose conjunctivæ and skin there were numerous petechial hæmorrhages, together with crusted blood about the gums. Both pleural cavities were distended by blood-stained fluid. In the anterior mediastinum, corresponding to the position normally occupied by the thymus, was a massive tumor, which extended downward from the jugular fossa to the level of the crura of the diaphragm and posteriorly to the spinal column, molding the aorta, pulmonary artery and trachea into its substance. On the left side, it brought about extensive infiltration of the diaphragm and of the pleura in the region of the apex of the left lung, the pleura in this situation being thickened and nodular. The liver was enlarged and studded with minute whitish areas. The submaxillary lymph-nodes on the left side were markedly enlarged, as were the axillary and inguinal nodes on both sides, and the mesenteric nodes, all of them discrete and fairly firm to the touch. The spleen was increased in size, weighing 350 grams, but, on section, showed no indications of tumor growth. There were numerous petechial hæmorrhages in the epicardium, in the mediastinal tumor itself, and in many of the lymph-nodes.

*Histology*—Microscopic sections from the growth of the thymic region and from lymph-nodes in various parts of the body show thickly cellular lymphocytic collections supported by an almost imperceptible stroma of connective tissue with, in both situations, a sprinkling of small injected blood-vessels. Sections from the pleura reveal infiltration

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of its walls by hordes of lymphocytes, the underlying alveoli being compressed. In the diaphragm the muscle fibres are widely separated by myriads of similar cells, in other places the muscle tissues are completely replaced by them. In the liver are large and small interstitial and intralobular collections of lymphocytes, together with the intrusion of many lymphocytes into the blood of the sinusoids.

CASE XVI—Male, aged thirty-eight years, a clerk, admitted December 2, 1924, died December 29, 1924. Little could be learned of his history, except that for two weeks past he had complained of cough and precordial pain. At the time of admission, there was a mass of enlarged lymph-nodes in the left submaxillary region, 5 centimetres in diameter. The left posterior cervical nodes were enlarged, forming a mass 10 by 5 centimetres. Enlarged lymph-nodes were present in both axillæ, those in the right forming a mass about 4 centimetres in diameter. The inguinal lymph-nodes were moderately enlarged. The liver was not felt. The spleen was palpable on deep inspiration under the costal margin in the anterior axillary line.

During the twenty-seven days that the patient was under observation, petechiæ appeared in various parts of the body and, on the ninth day there was bleeding from the nose. The temperature for the first twelve days pursued an irregular course, averaging 102.5° F in the evening. For the next six days it varied from 100° to 101° F and finally became septic in type. The patient now complained of sweats, cough and intermittent dyspnoea. On the second day after admission, the blood count revealed 14,400 leucocytes with a differential count of 9 per cent polynuclear neutrophils and 91 per cent immature lymphocytes. All subsequent counts were virtually the same. The left chest was tapped on three occasions for a total of some 3,500 cubic centimetres of fluid.

*Autopsy*—On opening the chest, the anterior mediastinum was found to be completely occupied by a firm wedge-shaped tumor which measured 12.5 by 6 centimetres and which was attached to the lungs on both sides. On the left, an extension ran downward over the anterior surface of the pericardium as far as the diaphragm and infiltrated the pericardium and the anterior margin of the left lung. Lymph-node enlargements were encountered in the neck, axillæ and groins, and there were one or two slightly enlarged nodes in the retroperitoneal region. The rest of the lymphatic system, including the spleen, showed nothing worthy of note.

*Histology*—Microscopic sections from the mass in the region of the thymus show a densely cellular growth of lymphocytes in which the cells are arranged in islands of variable shape and size, but in which streak-like formations occur with frequency. In the lymph-nodes the lymphoid cells stain rather less intensely and tend to follow a more diffuse arrangement. In the spleen are numbers of moderately hyperplastic lymphoid follicles, together with a sprinkling of lymphoid cells and fairly numerous lymphocytic clusters lying in the sinuses, the appearance of the spleen as a whole being considerably more cellular than in ordinary circumstances. In the liver are to be seen minute aggregations of lymphocytes, particularly in the interstitial connective tissues, and many lymphocytes in the blood of the sinusoids.

CASE XVII—Male, aged four years, admitted March 7, 1927, died April 19, 1927. Eight weeks before admission, he developed signs of fluid in the left chest. The chest was tapped on six occasions and each time bloody fluid was obtained. On admission to the hospital, the child was pale, weak and dyspnoeic. All of the superficial lymph-nodes were enlarged to a moderate extent. During the six weeks that the child was under observation, the left arm became so oedematous that he could not move it and the left chest was tapped on three occasions, a total of 690 cubic centimetres of clear brownish fluid being withdrawn. The heart was markedly displaced to the right. During the interval of observation, oedema spread to include the face and neck, the right arm, and the right foot and leg. Ten days before death petechiæ and purpuric spots appeared in the skin. Numerous blood-counts revealed a leucocytosis varying from 15,700 to 50,000.

and the lymphocytes numbered between 66 and 95 per cent. Death occurred sixteen weeks after the onset of symptoms.

*Autopsy*—The lymph-nodes of the cervical, axillary and inguinal regions were palpable and varied in size from a small lima bean to an almond. The anterior mediastinum was filled by a large tumor adherent to, but not infiltrating, the sternum. The mass extended from the suprasternal notch to the diaphragm. It measured 16 centimetres in length, 10 centimetres in breadth and 8 centimetres in depth and simulated the shape of the thymus. The great vessels at the base of the heart were surrounded by the growth, which crossed the hilum of the lungs and descended behind the heart for a short distance. The mass was adherent to the parietal pericardium, but did not perforate it at any point, although the pericardium was completely surrounded by new growth except for one or two small oval areas. Anteriorly the tumor decussated at the pericardial attachment to the diaphragm and spread in a thin layer over the median portions of the diaphragmatic pleura and along the pleura covering the adjacent portions of the vertebral column. The lymph-nodes at the root of the lung were greatly enlarged. In the lower portion of the abdomen, the mesenteric and retroperitoneal lymph-nodes were slightly enlarged, the largest nodes being about  $\frac{1}{2}$  centimetre in length. The lymph-nodes in the region of the head of the pancreas were similarly involved as were those in the gastro-hepatic omentum and around the junction of the common and cystic ducts. The spleen weighed 90 grams and, on section, the follicles were prominent. The spleen was natural in shape.

*Histology*—Microscopic examination of the tumor in the thymus shows the presence of diffuse overgrowth of cells which are noticeably larger than the small lymphocytes and whose nuclei stain much less intensely. The cells are so closely packed that even under the oil immersion lens their individual shapes cannot be determined. In the secondary deposits, however, notably in the lymph-nodes, where the cells are more loosely arranged, examination under the oil immersion lens shows a small amount of cytoplasm and a relatively large nucleus, with few chromatic particles in it. The nucleus in some instances is rounded, in others it shows a slight indentation, and in still others it has a reniform appearance caused by a deep indentation at about its centre on one side. As far as can be told from fixed tissues, this cell corresponds to the large mononuclear lymphocyte or the transitional cell of Ehrlich's classification or to the monocyte of the modern hematologist. According to this interpretation, the patient died of acute monocytic leucemia.

#### HODGKIN'S DISEASE

CASE XVIII—Male, aged forty-six, admitted February 22, 1930, died four days later. The patient complained of shortness of breath of twelve weeks' duration. Physical examination on admission showed, in addition to dyspnoea, swelling of the ankles that, according to the patient, had been present for a period of four weeks, while the hands in the course of the past week had likewise commenced to swell. The face was cyanotic. The superficial veins of the neck were prominent and there was dullness over both upper lobes, especially on the left side, where the breath sounds were hoarse. Abdominal breathing was marked, and the superficial veins in the abdominal wall were prominent. X-ray examination revealed a massive growth in the upper anterior mediastinum, completely replacing the upper lobe of the right lung.

*Autopsy*—On removal of the sternum, a massive growth came into view. It measured 14 centimetres in length and 15 centimetres in breadth and extended deeply into the thorax. It was grayish white in color, firm, with a slightly undulating surface and completely filled the superior anterior mediastinum, displacing the heart and pericardium downward, the mass forming a sort of bridge between the lungs. The growth extended laterally, invading the anterior borders and replacing the substance of the upper lobes of both lungs for a distance of from 4 to 5 centimetres. It extended into the neck, particularly on the right side, in the form of two or three cords, dividing the lobes

of the thyroid. In the superior mediastinum the tumor embraced all the great vessels at the base of the heart, including the arch of the aorta and its branches, the pulmonary artery, the superior vena cava, and the subclavian veins, compressing but not invading or occluding them. The superior vena cava was invaded, and two or three cord-like extensions of tumor tissue projected into the lumen of the vein, growing directly downward, where they entered into the cavity of the right auricle. Inferiorly, the growth which pushed the pericardial sac downward, also invaded that cavity in its upper part, without, however, infiltrating the origin of the great vessels within the pericardium or the heart muscle. Posteriorly it eroded directly into the trachea and right bronchus, the eroded portions appearing as cream-colored areas several centimetres in length on the right side of the trachea, and extending thence for several centimetres into the walls of the corresponding bronchus.

*Histology*—Microscopic examination shows the presence of a diffuse overgrowth of lymphocytes lying in a fibroblastic stroma. Among the lymphocytes is an occasional cell of the large mononuclear variety and, rarely, a multinucleated cell of the myeloid type.

CASE XIX—A woman, fifty-six years of age, who complained of palpitation of the heart, shortness of breath and a cough of four months' duration, followed in the next three months by dilatation of the veins of the upper side of the chest on the left side, œdema of the corresponding portion of the chest wall and of the arm and, finally, by generalized œdema, dyspnoea followed by orthopnoea, and death six months later or thirteen months after the onset of symptoms.

*Autopsy*—There was a mass in the upper and anterior mediastinal regions, corresponding in its outline to that of the thymus. The mass measured 18 centimetres in a downward direction and 11 centimetres transversely. It projected through the upper aperture of the thorax and invaded the right lobe of the thyroid for a distance of 3 centimetres. The mass compressed the upper lobe of the right lung and extended backward around the great vessels at the base of the heart, where it compressed the trachea and displaced it to the right, penetrating its walls for a distance of 8 centimetres without producing ulceration of its mucous membrane. The left pleural sac contained 1,350 cubic centimetres of fluid. The spleen was not involved.

*Histology*—Microscopic examination of the mediastinal growth and of its extensions into the thyroid and trachea shows the presence of preponderating numbers of lymphoid cells, among which are mononuclear and multinuclear giant cells, the latter of the lobulated or myeloid type, a few plasma cells, and numbers of eosinophiles.

CASE XX—Male, aged twenty-seven, admitted May 30, 1930, died October 18, 1930. Six years before admission the patient developed an enlarged node beneath the right ear. The node was removed and microscopic examination showed the histology of Hodgkin's disease. The patient stated that in the course of six years he had developed at various times similar enlargements in the left side of the neck and in the axilla, for which, at intervals, he had received X-ray exposures, the nodes apparently remaining stationary during treatment and enlarging when treatment was discontinued. A year before entering the hospital the patient gave up work because of increasing weakness. On admission to the hospital, the spleen was palpable just below the costal margin, and marked enlargement of the lymph-nodes was noted beneath the angle of the left jaw and in the region of the mastoid process on the right side, in the right axilla, in both supraclavicular fossæ, and in both groins. The patient complained of no pressure symptoms until six weeks after admission, when he stated that there was a distressing sensation of pressure "deep" in the chest behind the middle of the sternum. About two months after this, he began to complain of difficulty in swallowing. Death occurred three months and one week after the onset of pressure signs within the thorax.

*Autopsy*—On inspection, the body showed marked enlargement of the nodes in the neck below both ears and in the axillary region. In the region of the thymus there was a growth which measured 12 by 6 by 4 centimetres. It lay directly in the mid-line



between the lungs, extending from the level of the suprasternal notch above to the auriculo-ventricular groove below, and presented an indentation at its lower pole. On the left side it was entirely free, on the right side it infiltrated the anterior border of the lung for a distance of 4 centimetres in a lateral and 6 centimetres in a downward direction. The growth surrounded and compressed all the great vessels at the base of the heart and wrapped itself around the trachea in such form as to present isolated nodules posteriorly between the trachea in front and the œsophagus behind. It penetrated the upper and anterior portion of the pericardium in the form of twenty or more, large or small, rounded, oval or undulating, fused masses, presenting, on section, exactly the same naked-eye appearance as that of the original growth in the thymic region. One of these masses, which measured 4 centimetres in breadth, 2 centimetres in thickness and 2 centimetres in depth, lay directly in the anterior wall of the aorta. Similar but smaller nodules were to be seen in the wall of the pulmonary artery at its commencement. The pericardium enclosed 350 cubic centimetres of dark amber-colored fluid containing quantities of soft, somewhat gelatinous material. Both layers of the pericardium were diffusely covered with fibrinous exudate. The peribronchial lymph-nodes were enlarged, measuring from 1 to 5 centimetres, some of them discrete, others fused, all of them were infiltrated. Section of the right lung through the area of infiltration showed the presence of huge quantities of new growth extending into the substance of the lung for a distance of about 5 centimetres, the invading tissue being arranged for the greater part around the smaller bronchi, frequently occluding or partially occluding their lumina. Between the individual small bronchi, the lung tissue was diffusely infiltrated by new growth. The spleen was enlarged, it weighed 425 grams and measured 16 by 11.5 by 4 centimetres. Projecting beneath the capsule were numerous white masses of irregular size which, on section, were so richly distributed through the splenic pulp as almost completely to replace it. At one end, in fact, about half of the spleen was almost completely replaced by a firm, pearly gray growth which projected above the surface in the form of closely packed, pinhead-sized or larger foci. The liver weighed 2,800 grams and appeared to be well preserved. The retroperitoneal lymph nodes were closely packed and lay on either side of the vertebral column, forming a mass about 20 centimetres long, 10 centimetres in thickness and 10 centimetres in width.

*Histology*—Microscopic examination of tissues removed from various parts of the body shows the histologic changes characteristic of Hodgkin's disease. In the lymph-nodes the architecture is completely replaced by the overgrowth of connective tissue which, for the greater part, is thickened and hyaline and encloses variable numbers of lymphocytes and innumerable mononuclear and multinuclear giant cells.

CASE XXI—Female, aged thirty-two, admitted May 1, 1917, died June 17, 1917. She complained of "asthmatic" attacks of two years' duration. In the past year difficulty in breathing had increased to such an extent that she was unable to lie down night or day. At the time of admission orthopnea was distressing and both upper extremities and the anterior chest wall were œdematous. Over the right side of the chest anteriorly the percussion note was flat and expiration was high-pitched and hissing, although not frankly bronchial, and the voice sounds were high-pitched and increased in quality. The spleen was not felt. The edge of the liver was palpable about 5 centimetres below the right costal slope, and there were signs of fluid in the left chest. During the seven weeks that the patient remained in the hospital, the left chest was tapped five times and on each occasion from 1,000 to 1,500 cubic centimetres of fluid were removed. The X-ray report was to the effect that there was a large area of diminished illumination in the right pulmonic field, which was interpreted as due to a tumor in the anterior mediastinum.

*Autopsy*—The anterior chest wall was œdematous. On opening the body a growth was apparent in the region normally occupied by the thymus. The growth measured 25 centimetres in length and 18 centimetres in thickness and was firm in consistence. It presented a whitish or faintly cream-colored substance and extended downward in

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such manner as to obliterate the upper part of the right pleural cavity and to invade and replace almost the whole of the two upper lobes of the right lung. The lower lobe of the lung was not involved. Scattered through the substance of both lungs were numbers of large and small, circumscribed nodules made up of tissue of identical appearance with that in the main growth. The peribronchial nodes were greatly enlarged, as were those lying at the sides of the œsophagus. The cervical and abdominal nodes were unchanged. The left pleura enclosed about 2,000 cubic centimetres of clear yellow fluid. The spleen was slightly enlarged, but was not nodular.

*Histology*—Microscopic examination of the growth in the thymic region shows a connective tissue reticulum supporting great numbers of lymphoid cells, among which are prominent numbers of large mononuclear cells and an occasional multinuclear giant cell of the myeloid type. Microscopic examination of the peribronchial lymph-nodes reveals large collections of lymphocytes, among which are mononuclear and multinuclear giant cells, the islands being separated by rather coarse bands of mature connective tissue. In places these islands are permeated and partially or completely replaced by a dense, pinkish staining, poorly nucleated, hyaline reticulum, such as has been described as a local attempt at healing. The nodules in the lung are made up almost exclusively of lymphoid cells, but among them are disclosed a few mononuclear giant cells and, rarely, a multinuclear cell of the myeloid type. Moderate numbers of eosinophiles are to be seen, usually at the periphery of the lymphoid collections. The spleen, and liver microscopically are well preserved.

CASE XXII—Male, aged forty-four, admitted April 30, 1931, died June 13, 1931. On admission, the patient stated that in 1928 he noticed that he became short of breath on exertion, that this was slowly progressive and that he was easily fatigued. About six months later he experienced a choking sensation on exertion. Shortly after that he detected a swelling in the neck and observed that there was loss of some twenty pounds in weight. Shortly after admission he developed a dry cough and complained of itching of the skin. Deep X-ray therapy relieved considerably the dyspnoea and cough and the patient was discharged from the hospital improved. About five months later he was readmitted complaining of return of his original symptoms. At this time, physical examination revealed marked orthopnoea, cyanosis, œdema of the left upper extremity and of the corresponding side of the chest and leg, together with signs of an effusion into the pericardial sac.

*Autopsy*—On opening the chest, an enormous mass came into view lying in the middle line and occupying the space normally assigned to the thymus. The mass measured 18 centimetres in length, 7.5 centimetres in width at the upper level of the manubrium, and 6 centimetres at the inferior margin. The growth resembled the shape of the thymus, decussating at its lower end to form a distinct notch. The mass was solid in consistence, whitish in color. It insinuated itself around the structures at the base of the heart and was firmly attached to the pericardium. It was fixed to the anterior margin of the right lung and on the left side penetrated deeply into the substance of the lung, almost completely replacing the upper lobe. Below, the growth sent a prolongation downward over the pericardium into the diaphragm. Above, the growth was continuous with an irregularly nodular mass lying in the lower part of the right side of the neck. The growth extended into the upper portion of the pericardium and set up within the pericardium a collection of yellowish nodular masses, almost completely obliterating the upper third of the cavity. The muscle substance of both auricles and of the upper third of the right ventricle, both anteriorly and posteriorly, was apparently completely replaced by nodular deposits. The retroperitoneal lymph-nodes in the region of the pancreas were greatly enlarged. There were a few enlarged, discrete lymph-nodes in the region of the internal abdominal ring on both sides. The spleen was normal in size and, except for congestion, showed no naked-eye changes. The same was true of the liver.

*Histology*—Microscopic examination of sections removed from lymph-nodes in various parts of the body reveals complete obliteration of the normal architecture and replacement by connective tissue overgrowth, the fibrils of which in many places are markedly sclerotic. Scattered through the connective tissue interstices are moderate numbers of round cells of the lymphocytic type and relatively very large numbers of mononuclear and multinuclear giant cells, together with a few eosinophiles. Microscopic examination of the liver and spleen shows no histologic indications of Hodgkin's disease whatsoever.

## THE EPITHELIOMATA

CASE XXIII—Male, aged fifty-six, admitted to Bellevue Hospital July 7, 1930, died August 13, 1930. The patient stated that one morning four weeks previously he awakened with a stiff neck. Since that time his head tended to fall forward and in the past two weeks he has had to support his head with his hands. At the same time the patient complained of some difficulty in swallowing, regurgitating fluid through the nose. He also complained of progressive difficulty in chewing and on several occasions had to be fed by a stomach tube. Neurologic examination revealed a left-sided Horner's syndrome, weakness of the left side of the palate and deviation of the tongue to the left. All the neck muscles were weak. The muscular power of the limbs was entirely normal. The neurologic findings were otherwise negative. The patient remained in the hospital for a period of about five weeks and died suddenly in an acute attack of dyspnoea attended by cyanosis. During his stay in the hospital the patient was regarded as suffering from a high cervical and bulbar lesion, probably of vascular origin.

*Autopsy*—On removing the sternum, the superior mediastinum corresponding to the position normally occupied by the thymus showed a growth which was roughly "heart shaped," with the notch downward. The tumor measured 7 centimetres in length, 5 centimetres in width, and 3 centimetres in thickness. The right border was free, the left border was attached to the anterior margin of the upper lobe of the left lung, into the substance of which it penetrated for a distance of several centimetres. Below, the tumor rested on the anterior surface of the pericardial sac to which it was adherent, but through which it did not penetrate. The consistence of the tumor was firm and, on section, its substance was white and granular. There were no secondary deposits in any part of the body.

*Histology*—Microscopic examination of sections removed from various parts of the tumor shows complete disappearance of the normal arrangement of cortex and medulla. On the other hand, the tumor, particularly in its more centrally situated parts, is made up of large numbers of epithelial reticulum cells and relatively small numbers of lymphocytes. The epithelial reticulum cells are large, irregular in shape, distinct in outline, and are characterized by the presence of a scanty, pale-staining cytoplasm, enclosing a large vesicular nucleus provided with an eccentrically placed acidophilic nucleolus and by the presence of delicate cytoplasmic fibrils. In places these epithelial reticulum cells occur singly, in other areas they are arranged in small groups, sometimes as large islands. Perhaps the most striking feature in the whole microscopic picture is to be found in the concentric condensation of the epithelial reticulum cells to form Hassall's corpuscles. These latter bodies are present in all stages of development, from the early grouping of reticulum cells, through the stage of concentric lamellation, to the final stage where the cytoplasm of the centrally situated cells has undergone granular or hyaline degeneration, the nuclei shrunken and pycnotic. Where the tumor invades the lung tissue there are numbers of epithelial reticulum cells which are arranged in insular formation, with a scant admixture of lymphocytes and no tendency in the direction of whorl formation.

CASE XXIV—A man, fifty-eight years of age, who, on admission to the hospital, complained of severe burning pains in the back that had been present for three weeks

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Three days before admission, these pains became so excruciating that he was unable to stand and had to give up his work and take to his bed. In addition, he complained of pain in the upper sternal region on swallowing. At the time of admission the entire dorsal spine was rigid and rigidity was increased by movements of the trunk. Two weeks later, the patient could not move the body below the waist. The superficial reflexes were abolished. The knee jerks were preserved and the patient was insensible to pain up to a girdle point about 5 centimetres above the lower border of the ribs. On the following day there were complete paralysis and anaesthesia of the entire body below the level corresponding to the fifth dorsal segment. The knee jerks had now disappeared and there was a bilateral Babinski. The patient suffered from retention of urine and was incontinent of faeces. The spinal column was opened, surgically, from the fourth cervical to the second dorsal vertebrae and a tumor was removed that measured 6 by 2.5 centimetres. In the succeeding three months the patient gradually failed and death occurred.

*Autopsy*—On opening the thorax, a mass came into view corresponding to the position normally occupied by the thymus. The mass measured 10 by 8 by 3 centimetres and was roughly triangular in outline with the base upward. It was attached to the margin of the left lung for a distance of about 6 centimetres but was otherwise free. Both lungs were studded with metastatic nodules, varying in size from 1 to 2 centimetres. The spinal cord corresponding to the excised laminae was markedly compressed and there was a wart-like metastatic growth in the dura at about the level of the third dorsal vertebra.

*Histology*—Microscopically, the fibrous ground substance divides and subdivides in such manner as to segregate the tumor cells into groups which vary markedly both in size and shape. Perhaps the commonest variety is a rather small cell with a deeply chromatic homogeneous nucleus. Under ordinary magnification, this cell appears to be rounded and of about the size of a lymphocyte, but, when viewed under the oil immersion lens with properly diminished illumination, it is seen to be irregularly rounded or even polyhedral and to possess a quantity of pale, smooth, or finely granular cytoplasm. This appears to be the cell of origin of the tumor and it may be traced through various transitional stages until it acquires a flattened form. These flattened forms give rise to still larger cells of variable morphology. A noticeable feature is that they show attempts to become arranged in whorls and thus to present a resemblance to Hassall's bodies.

### SPINDLE-CELL SARCOMA

**CASE XXV**—Male, aged forty, admitted December 2, 1930, died December 8, 1930. In June, 1930, the patient's illness commenced with cough and expectoration and anorexia. He remained at work until September 1, when he had to discontinue because of weakness. In that length of time his chest was tapped on five different occasions. The patient stated that he was short of breath before the tapping and somewhat relieved by it. Two months before admission he became markedly dyspnoeic, dyspnoea finally changing to orthopnoea. At the time of admission, he was orthopnoeic and slightly cyanotic. The right chest showed signs of fluid. At this time the patient stated that he had recently noticed that it was becoming increasingly difficult for him to swallow, either solid or liquid food.

*Autopsy*—In the anterior and superior mediastinum, extending from the level of the suprasternal notch downward in the middle line in front of the pericardium as far as the apex of the heart, was a tumor which was irregularly nodular but which simulated the shape and occupied the position of the thymus. It measured 17 centimetres in a downward direction, but was otherwise too indefinite in distribution to be measured even with approximate accuracy. At the base of the heart it molded itself around all the great structures, including the aorta, the carotid vessels, trachea and oesophagus, burying them in a solid mass of tumor tissue. Posteriorly it extended into the right

lung along the connective tissue planes surrounding the bronchi, along which it traveled fan-fashion to the extreme base of the right lower lobe, compressing but not invading the large bronchus just after its bifurcation, except for the presence of some ten or fifteen whitish, submucous elevations which had not gone on to the process of ulceration. The left lung was free. Posteriorly the tumor extended from the level of the suprasternal notch downward to the body of the seventh thoracic vertebra, in other words, for a distance of approximately 15 centimetres. Anteriorly the tumor extended directly into the upper aspect of the pericardial sac and into the posterior part of the auricle, where it presented itself as a large, irregularly-outlined, cream-colored, mound-like projection which measured 7 centimetres in length and 4 centimetres in breadth. The endocardium covering this projection was intact. Posteriorly the tumor likewise projected itself into the pericardium at its upper aspect and into the posterior wall of the left auricle, where it presented itself as an irregularly outlined, mound-like growth, representing a replica of the one in the opposite auricle, except for the fact that the one in the left auricle was larger. Posteriorly the tumor at one point directly invaded the œsophagus in the form of a soft, cream-colored, mushroom-like growth, measuring about 1 centimetre in diameter and 3 millimetres in height, this lay at the level of about the fifth thoracic vertebra.

*Histology*—Microscopic examination shows a dense fibroblastic stroma imbedded in which are large and small islands of small, rather richly chromatic tumor cells. Many are spindle, others oat shaped. These two differently shaped cells are present in about equal proportions, one or the other type preponderating, however, in different parts of the tumor. Except for the absence of any vascular unit, the shape and arrangement of the cells reminds one very much of perithelioma. In the absence of any vascular unit, however, this diagnosis seems scarcely justified and the tumor appears to be best classified as a spindle-cell sarcoma arising from the connective tissue framework of the thymus.

#### GROWTH BEHAVIOR

Many of the thymic growths here recorded presented features of growth behavior which made it possible, within certain limits, to trace their evolution with something approaching a consecutive course. In three of the cases, the growths were obviously in an early stage of development. In one of them, the tumor—a reticulum-cell epithelioma with reproduction of Hassall's bodies—was encountered at autopsy as an accidental finding. It presented itself as a solid mass which occupied the position of the thymus and was "heart shaped." The base was unattached and directed upward, the notched apex downward. The growth was attached to but did not penetrate the pericardium. Its right border was free. The left border was fixed to the margin of the lung and penetrated along the line of the bronchus for a distance of 2 or 3 centimetres. In a second case the growth in the thymus—a perithelioma—was unattached except for the fact that it grew downward and penetrated the right lung along the line of the large bronchus. As illustrating the perversity of neoplastic behavior, in a third case—an epithelioma of the thymic remains—the original growth was comparatively small in size and was attached only to the margin of the left lung. In addition, however, the lungs were riddled with metastatic deposits and a large metastasis in the upper spine so effectually compressed the cord as to bring about complete paraplegia. Thus, it appears that thymic growths, early in their evolution, display a tendency mechanically to infiltrate the lungs. Their subsequent

behavior is such as to bring about an array of destructive changes in the thoracic viscera that is seldom paralleled in the domain of disease—penetration of the pericardium and invasion of the heart muscle, infiltration of the pleura, sometimes as isolated nodules, oftener over a diffuse or prairie-like expanse, compression and invasion of lung tissue involving one, sometimes two or more lobes, often with secondary infection and abscess formation, infiltration of adjacent muscles, such as the intercostals and the diaphragm, compression and infiltration of the œsophagus, trachea and bronchi, and of the walls of such great vessels as the aorta, pulmonary artery, the innominate and jugular veins and the superior vena cava, enlargement of lymph-nodes, metastatic or otherwise, in different parts of the thorax, sometimes elsewhere, and, finally, by such effects as are revealed by the transudation of enormous quantities of fluid into the pleural and pericardial sacs, the peritoneum or subcutaneous tissues. Although in most of these cases by far the greater burden of attack is borne by intrathoracic structures, the program of destruction not uncommonly is extended to include metastatic deposits in extrathoracic viscera, among them secondary lesions in the lymph-nodes in various parts of the body and in the liver, adrenals, pancreas, thyroid, kidney and bones, the peritheliomata, in this respect, displaying particularly vicious qualities.

*Infiltration of the Pericardium and Heart*—Of the twenty-five cases of tumors and tumor-like growths of the thymic remains, the pericardium was invaded sixteen times (64 per cent)—six times by lymphosarcoma, six times by perithelioma, once by a spindle-cell sarcoma, and three times in Hodgkin's disease. Of the six lymphosarcomata, the heart muscle was invaded five times. Of the six cases of perithelioma, the heart muscle was invaded once. In one of the three cases of Hodgkin's disease, the heart muscle was extensively replaced.

Even from this small series of cases, it is evident that tumors of the thymic remains, notably the lymphosarcomata, show a marked inclination to infiltrate the pericardium and to invade the heart muscle. Penetration of the pericardium occurs practically always at the upper end of the sac, obviously because the pericardium lies directly in the pathway along which the growth finds it easiest to travel. In about one-half of the Bellevue Hospital series, the upper end of the pericardial sac presented multiple nodules which projected themselves into the cavity and stopped there. In other instances the tumor nodules advanced to include the walls of the intrapericardial portion of the aorta and the origin of the pulmonary artery, with or without associated changes in the heart muscle itself. Infiltration of the pericardium alone is a comparatively harmless procedure, since it usually occurs in nodules of such size, numbers and distribution as apparently to offer slight, if any, embarrassment to the movements of the heart, although it sometimes happens that they are apparently directly concerned in the initiation of exudates into the sac.

On the contrary, invasion of the heart muscle, in many instances at least,

is so extensive as obviously to impede the action of the heart and thus to contribute its share to those processes which conspire to terminate life. Here, again, the lymphosarcomata are the growths most frequently concerned. In one case of thymic lymphosarcoma the pericardium contained 200 cubic centimetres of fibrino-purulent exudate, the epicardial fat was diffusely infiltrated by tumor growth, the walls of both ventricles were thickened and rigid and were replaced to an almost unbelievable extent by tumor infiltrate, only islands of reddish musculature showing through at intervals. Microscopic examination of the heart wall showed the incursion of lymphocytes to the amazing extent that almost every individual fibre was separated from its fellow by a dense infiltrate of tumor cells, while the fibres themselves were compressed and their striations lost. In a second case both auricles were replaced and the epicardial fat of the right ventricle was infiltrated. In a third case the intrapericardial portion of the aorta and the commencement of the pulmonary artery were invaded by nodules of tumor tissue, in the anterior wall of the right auricle was a solitary nodule 1 centimetre in diameter at its base, the epicardial fat of the left ventricle was sprinkled with small nodules, and in the wall of the left ventricle were two or three nodules, the largest measuring about 1 centimetre in diameter at its base. In a fourth case the pericardium was distended by fibrino-purulent exudate and the heart muscle in the upper part of the left ventricle was replaced by tumor tissue. In a fifth case the muscular structures of the right auricle appeared to be completely replaced by tumor growth. In a sixth case both auricular walls posteriorly were extensively invaded by a perithelial sarcoma. In a case of Hodgkin's disease, on the other hand, the muscle tissues of both auricles and of the upper third of the right ventricle, anteriorly and posteriorly, were practically completely replaced by new growth, the degree of invasion representing the most extensive thus far encountered in our experience at Bellevue Hospital.

*The Pleura, Bronchi and Lungs*—Growths of thymic origin show a propensity for invasion of the pleura, sometimes diffusely over a limited area, sometimes by metastatic nodules, but oftener covering vast sweeps of territory. In nine of the twenty-five cases in this series, the pleura was diffusely infiltrated in seven—five times by lymphosarcoma and twice by perithelioma. In the remaining two cases, both of them peritheliomata, the pleura was studded by metastatic nodules. As exemplifying the extent to which diffuse invasion of the pleura may occur, in one case of thymic lymphosarcoma the entire parietal and diaphragmatic pleura on the right side measured 0.5 centimetre in thickness. In a second case the whole of the parietal pleura on the right side was greatly thickened and presented a smooth, sheet-like, or, in places, an undulating surface. In one case a perithelioma of the thymic remains infiltrated both the parietal and visceral pleuræ on the left side, and in a second case the pleura covering the whole of the base of the right lung was similarly infiltrated.

In ten of the twenty-five cases of thymic tumors, the larger bronchi were

buried in tumor tissue. In ten cases the walls of the bronchi were infiltrated for variable distances and their lumina were encroached upon, sometimes almost completely occluded. This occurred four times in lymphosarcoma, four times in perithelioma, and twice in Hodgkin's disease.

In fourteen of the twenty-five cases the lungs were involved, oftenest the upper lobes, three times by compression and eleven times by infiltration. Occasionally the tumor would attach itself to the margin of one or both upper lobes, with a slight but nevertheless appreciable degree of infiltration of the lung substance. In two cases, however, both of them peritheliomata, the upper lobe of the right lung was practically completely replaced by tumor tissue and in one case almost two entire lobes of the right lung were invaded in Hodgkin's disease. In another case of Hodgkin's disease practically the whole of the upper lobe of the left lung was replaced.

*Symptoms and Signs, Diagnosis and Prognosis*—In tumors and tumor-like growths of the thymus and its remains, the absence of early signs, if I may so express myself, is one of the most frequent and dangerous symptoms. It is an example of the marvelous adaptability of tissues to the gradual incursions of a new growth and illustrates the extent to which disease may proceed without displaying any sign by which its presence may be detected. Growths of the type under discussion may so expand locally and infiltrate regionally as to bring about destructive changes in the thoracic viscera of such proportions as to excite wonder that the body could withstand these handicaps for so long a period, and yet the patient may carry this burden of disease for many months with no obvious signs of suffering. It is possible that the growth may be suspected if, in the examination of the chest the heart dullness continues upward toward the suprasternal notch, merging into flatness, and if, in the absence of aortic disease, there is dullness on either side of the manubrium in the first and second interspaces. If such signs are detected, particularly in association with early pressure changes, such as intermittent dyspnoea or hoarseness, or with unexplained superficial enlargements, lymph-node or otherwise, or with the signs of myasthenia gravis, attention should be focussed on the possibility of a thymic growth and confirmation sought by fluoroscopic or X-ray examinations, especially from the lateral aspect, and by microscopic investigation of any nodules which may be removable. Later, when the anatomical factors of safety are neutralized or exhausted, the effects of increased intrathoracic pressure are apt to assert themselves abruptly and to advance relentlessly—orthopnoea, cyanosis, cough, difficulty in swallowing, speech disturbances, inequality of the radial pulses, engorgement of the superficial veins, oedema of the chest wall and arms and sometimes of the legs, effusions into one or more of the thoracic serous sacs or into the peritoneum, and death within a few weeks or months after the initial manifestation of intrathoracic pressure disturbances.

In any event, accurate diagnosis of the variety of growth present is imperative from the standpoint of treatment and prognosis, and is to be predicated largely on the removal and microscopic examination of any



nodules which may be accessible. If it be shown that the lesion is that of lymphosarcoma or Hodgkin's disease, appropriate X-ray treatment, as already mentioned, may provide at least temporary relief from the horrors attendant on increased intrathoracic pressure. In epithelioma and the perithelial and spindle-cell sarcomata, improvement, on the contrary, temporary or otherwise, is scarcely to be anticipated.

*The Leucemic Conversion of Lymphosarcoma of the Thymus*—The term leucosarcoma was introduced by Sternberg<sup>7</sup> to denote a condition characterized by the presence in some part of the body of a tumor composed of lymphoid cells which are eventually poured into the blood in such numbers as to constitute a true leucemia. Two types of leucosarcoma are recognized. One, in which the original growth is made up of cells of the lymphoid variety, subsequent invasion of the blood stream representing a form of lymphoid leucemia, a second, in which the original focus of growth is composed of myelocytes, the discharge of which into the blood gives rise to leucemia of the myeloid type. Sternberg records eight cases, six of which were lymphoid and two myeloid. In four cases of the lymphoid variety the original growth was located in the upper anterior mediastinum corresponding to the position normally occupied by the thymus or its remains. In the three cases of lymphoid leucosarcomatosis here recorded, the primary foci of growth were likewise to be found in lymphosarcomata of the thymus.

The recognition of lymphoid leucosarcoma depends, first, on the existence of a tumor in some part of the body that, on microscopic examination, reveals the histological picture of lymphosarcoma, the cells of which, contrary to the usual arrangement, consist almost exclusively of large lymphocytes with an admixture of small cells. In occasional instances this order is reversed. In the greater number of examples of leucosarcoma thus far recorded, however, the large lymphocyte was described as the preponderating cell, both in the primary focus of growth and in the blood. In other instances, on the contrary, the cells in both places have been described as of the type of small lymphocytes. Second, the original focus of growth may exist for weeks, months or years before invasion of the blood stream occurs, but involvement of the blood, when it does take place, is abrupt, and the process then advances with astonishing rapidity.

*Thymic Growths and Myasthenia Gravis*—The condition known as myasthenia gravis is characterized by unusually rapid fatigability of certain muscles, notably those of the jaw, larynx, the muscles of deglutition, the upper eyelids and of the face, sometimes of the muscular system as a whole. The condition is so often associated with neoplastic lesions of the thymus as strongly to indicate an etiological relationship between them. In the majority of cases thus far recorded, the original thymic growths were lymphosarcomata. Mandelbaum and Celler's case, on the other hand, was a perithelioma, and, of the two examples recorded in this paper, one was a reticulum-cell epithelioma, the other a lymphosarcoma. In certain of the recorded cases, minute collections of lymphocytes have been described, not alone in the

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muscle tissues in various parts of the body, but in the liver, adrenal, thyroid, kidney, peripancreatic fat and elsewhere. They were found in the muscle tissues in the second case described in this paper, namely, a thymic lymphosarcoma. In such circumstances, however, it is difficult to conceive of any reciprocal relationship between myasthenia gravis and lymphocytic collections in the localities named, and, indeed, it is yet to be determined if such cell foci deviate materially from apparently identical collections in the tissues in conditions which do not depart noticeably from the normal. Nor does it seem reasonable to incriminate any particular type of thymic growth as an instrument in the causation of myasthenia gravis—it is apparently some disturbance of function produced by the growth, rather than the nature of the growth itself that is to be invoked as an explanatory factor. Nevertheless, myasthenia gravis and thymic neoplasms occur sufficiently often in company with one another to warrant investigation of the thymic region in every case in which the symptoms of myasthenia gravis present themselves. In view of the fact that lymphosarcoma assumes such a prominent rôle among neoplasms of the thymus and since this type of growth is not uncommonly amenable to treatment, the clinical detection of its alliance with myasthenia gravis assumes a place of great importance.

### SUMMARY

1 At least five different types of malignant tumors or tumor-like growths are capable of arising in the thymus or its remains, namely, perithelioma from the connective tissue of the walls of small blood vessels, lymphosarcoma from the lymphocytic elements, epithelioma from the epithelial reticulum cells, spindle-cell sarcoma from the connective tissue framework and, finally, Hodgkin's disease, which finds in the lymphocytes of the thymus those cells that appear to be prerequisite for its development.

2 Of these five varieties of new growth, the lymphosarcomata and Hodgkin's disease are favorable types for treatment by radiation, in which circumstances the outlook is not altogether without promise. On the other hand, the peritheliomata, epitheliomata and spindle-cell sarcomata, as treatment is now practiced, are hopeless from the outset. Perhaps in the latter connection it is not trespassing too far to prophesy that at least some of these growths may eventually be approached surgically. In such an event, early diagnosis is, of course, imperative. For example, in Case XXIII recorded in this paper, a small epithelioma of the thymus was associated with the signs of myasthenia gravis and, except for the fact that it infiltrated the margin of the left lung, the growth lay otherwise free within the thorax and offered, apparently, the possibility of surgical removal of an otherwise irremediable growth.

3 In a considerable proportion of all cases, thymic growths display a tendency to confine themselves largely or even exclusively to the structures of the thoracic cavity where, however, their ultimate degree of destructivity is scarcely to be paralleled in the domain of neoplasia. Particularly note-

worthy is the propensity of such growths to destroy lung tissue either by compression or by direct infiltration, and to penetrate the pericardium and invade the heart muscle. In still other instances, in addition, secondary deposits are set up in extrathoracic tissues, notably by the perithelial sarcomata.

4 (a) In spite of the extensive local invasion and destruction of tissues produced by thymic growths, symptoms and signs of increased intrathoracic pressure are not uncommonly delayed for a long period of time—often months, sometimes, it is estimated, for a year or more. When such symptoms and signs finally assert themselves, however, they are apt to do so abruptly and to progress with astonishing rapidity, death occurring in a few weeks or months. It is a noteworthy example of the adaptability of mobile and compressible structures to the gradual encroachment of pressure and of the rapidity with which death occurs when the process of adaptation is exhausted.

(b) In a second group of cases, usually late in their course and in association with pressure signs, the thymic lymphosarcomata may suddenly commence to pour their lymphocytes into the blood, constituting an acute lymphocytic leucemia, in this manner terminating life. It need scarcely be pointed out that this phenomenon is limited to the lymphosarcomata and that leucemic conversion of the other malignant tumors and tumor-like growths of the thymus is unknown.

(c) A third and small, but extremely important group of thymic tumors is associated with the symptoms of myasthenia gravis. This remarkable alliance has been noted in about 20 per cent of all cases of myasthenia gravis thus far investigated at autopsy. It occurs sufficiently often, however, to be sought for in every case and its detection is obviously important from the standpoint of treatment. The association in question is not limited to any single variety of thymic growth, but has been noted in simple hyperplasia of the thymus and in at least three widely divergent forms of thymic tumors, namely, lymphosarcoma, perithelioma and epithelioma. Its significance lies, not so much in the nature or geographical extent of the thymic lesion, as in the functional disturbances for which these lesions sometimes appear to act as sponsor.

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# SUTURING WOUNDS OF THE HEART

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THE modern era of surgery of the central circulatory system began with the bold attempts of Farina,<sup>1</sup> Cappelen,<sup>2</sup> and Rehn<sup>3</sup> in 1895-1896 to suture wounds of the heart. It had been casually considered before this for Larrey<sup>4</sup> had successfully drained a hemo-pericardium, but in 1883 Billroth<sup>5</sup> made the ridiculous statement "that the surgeon who should attempt to suture a wound of the heart would lose the respect of his colleagues," and as late as 1896 Stephen Paget<sup>6</sup> stated that "surgery of the heart has probably reached the limits set by nature to all surgery, no new method and no new discovery can overcome the natural difficulties that attend a wound of the heart."

Since the occasion for cardiorrhaphy arises so rarely the surgeon must have in mind definite principles and methods rather than accept the curious statement of Sir Charles Ballance<sup>7</sup> that he should regard the suture of heart wounds merely as a part of the "day's work, and just as he plunges his hand into the abdomen into a mass of blood in a case of ruptured spleen or in a case of ruptured tubal gestation and seizes the bleeding spot, so he will now plunge his hand into the pericardium and seize the heart, and, by digital compression, control the hæmorrhage and proceed to suture the heart." That the mortality in the series of heart wounds reported in 1909<sup>8</sup> was 63 per cent and 33 per cent in the series reported in 1923<sup>9</sup> shows that a better technic was being evolved just as it has been in the operations for ruptured spleen and ruptured tubal gestation, since the "day's work" for a surgeon in 1909 differed little from that in 1923.

The object of this paper is to set out certain definite principles in diagnosis and treatment of cardiac wounds together with a technic of suture applicable to most cases. Two successful instances are shown (Figs 1 and 2).

*Diagnosis*—Every attempt at accurate diagnosis should be made before operation since exposure of the heart is in itself hazardous. However, if unable to determine for certain whether or not an injury exists, it is safer to do an exploratory pericardiotomy than to run the chance of death from heart tamponade or hæmorrhage. The position of the wound is of some importance in diagnosis, but the course of a bullet or even a knife thrust is notoriously misleading. Wounds just to the left of the sternum from the second to the fifth rib are the most apt to cause cardiac injury.

*There is usually a history of freedom from any symptoms for five or ten minutes after injury, followed quickly by exhaustion and collapse.* Bleeding is profuse at first and with the stage of collapse is checked. Both the collapse and the checking of the hæmorrhage are due to tamponade of the heart. The

patient is usually frightened, cold, clammy, and thirsty. The pulse may be weak or absent, and the arterial pressure lowered or imperceptible. The venous pressure is raised as is evidenced by prominent, strutted, external jugular veins. Rontgenogram of the heart is of no value since death may occur from a rapidly occurring tamponade from an amount of blood too small to cause a noticeable change in the size and contour of the cardiac shadow. The electrocardiogram is usually normal for several hours even though tamponade is present or even if a coronary vessel is severed. The main point in diagnosis is the recognition of tamponade of the heart from blood, thereby



FIG 1



FIG 2

FIG 1—Patient two months after suture of wound of right ventricle. Exposure by skin and muscle flap and removal of three costal cartilages.

FIG 2—Patient two months after suture of wound of left ventricle. Exposure by transverse incision with removal of fifth costal cartilage and retraction of fourth and sixth cartilages.

raising the venous pressure by pressure on the vena cavæ, and lowering the arterial pressure by prevention of filling and therefore of emptying of the heart. The history of a symptomless interval, similar to that seen in intracranial hæmorrhage, during the time the pericardium fills with blood, is the most important point in the history.

Having established a diagnosis, immediate operation should be carried out. If the pulse is becoming weaker or is imperceptible and the arterial blood pressure is dropping, scrubbing the hands and the usual operating-room preparations should be dispensed with. The instruments may be sterilized by placing them in alcohol and the operator and assistants will save much valuable time by mere use of sterile gowns and gloves. The incision should be planned to secure the best exposure in the quickest time and with the least shock. The median sternotomy (Duval-Barasty), certainly gives excellent

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exposure to all the heart and great vessels, but splitting the sternum requires a great deal of time, as does the closure of the wound, and is certainly productive of shock. It is mentioned merely to condemn it, since in cases of severe hæmorrhage or increasing tamponade, the patient would not likely survive. Operations should always be carried out on the left side even though the wound is to the right of the sternum. The position of the heart behind and to the left of the sternum makes exposure from the right side impossible. The intercostochondral thoracotomy (Spangaro), offers a rapid approach but not a particularly good exposure. It can be improved by removing one

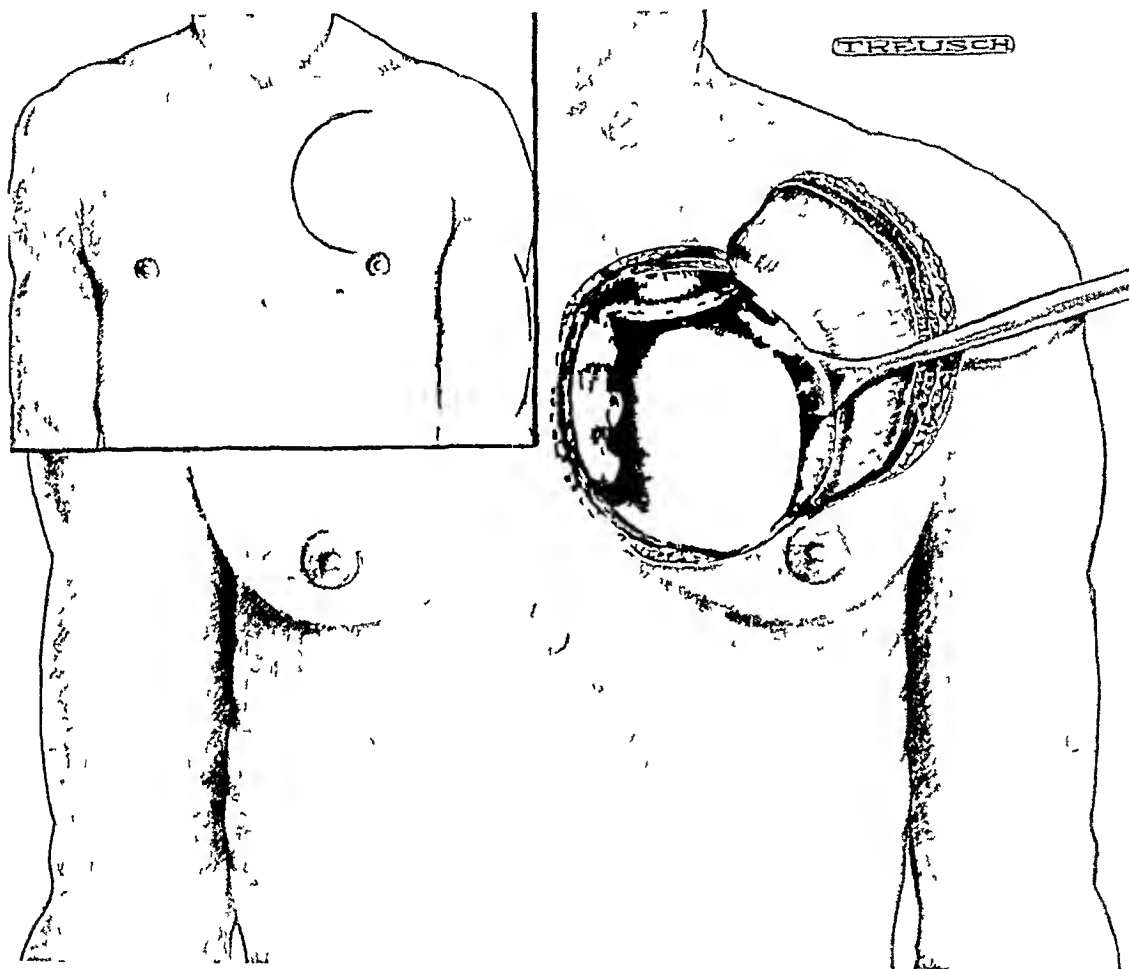


FIG 3—Method of flap exposure and removal of three costal cartilages

cartilage through the transverse incision and spreading the cartilages above and below it.

A third method and one giving excellent exposure is as follows: under procaine anæsthesia, a flap of skin, fascia, and muscle is turned outward, exposing the third, fourth and fifth left costal cartilages and ribs. The cartilages are removed, taking care not to injure the underlying pleura, and the internal mammary vessels are ligated. The parietal pleura is then carefully displaced outward and the pericardium exposed (Fig 3). The pericardial wound is then located and enlarged. If there is an appreciable amount of blood in the pericardium it will gush out on enlarging the wound,

and the contractions of the heart, being released from the tamponade, will increase in force. Should the heart be beating feebly, the tamponade should be immediately removed by passing a finger behind the heart and evacuating the blood and clots, and the heart stimulated by the injection of fifteen minims of 1-5,000 solution of adrenalin. The difficulty is in placing of the first hæmostatic suture, since with each heart beat the wound becomes obscured

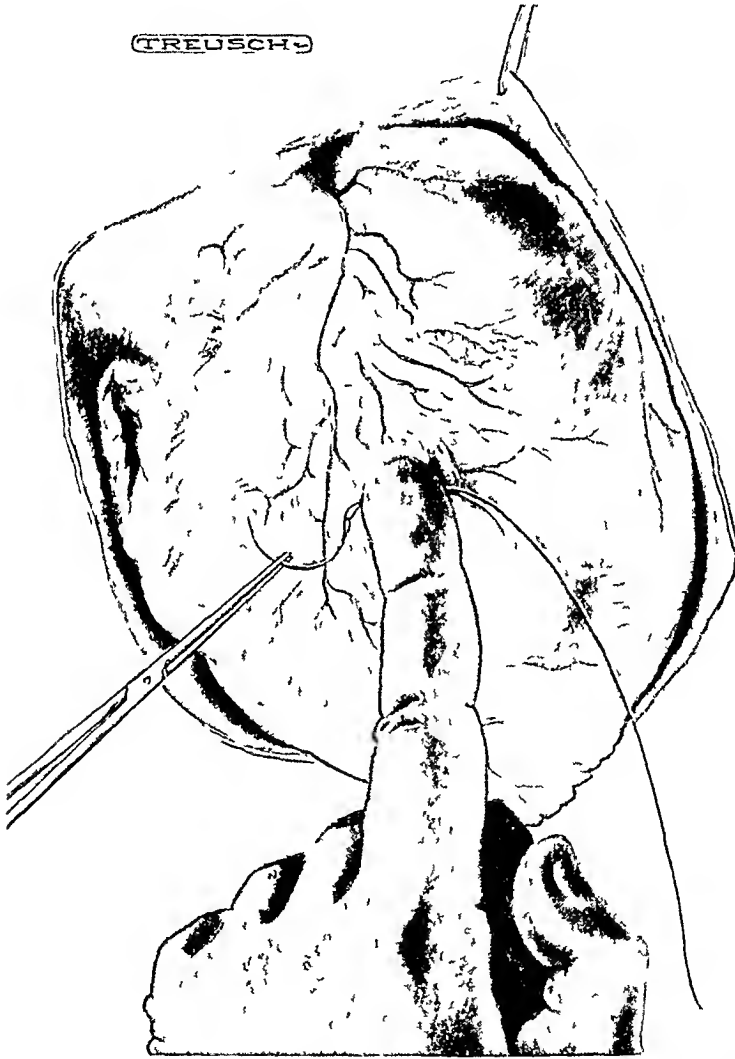


FIG. 4—Method of controlling bleeding if wound is anterior and near the apex. The index finger of the left hand is placed on the wound and the suture passed through the wound under the finger. This suture is then used for traction and hemostasis until the other hæmostatic sutures are placed.

with blood. If the index finger of the left hand is placed directly over the wound the flow will be stopped sufficiently long to allow the passage of a suture directly under the finger (Fig 4). Fine black silk (size A) is the suture of choice. This is left untied and held in the left hand for traction and hæmostasis, and two or three other sutures can then be readily passed to completely close the wound. Under no circumstances should the finger be

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placed *in* the wound, since the heart muscle is extremely friable and the wound will be immediately torn and enlarged

Should the wound be located in an axilla, behind the sternum, or posteriorly, the method described by Beck<sup>10</sup> is the procedure of choice. He advocates the placing of a stay suture at the apex, and with this the heart can be moved for inspection and steadied during suture. "The apex suture is held under traction between the thumb and third finger of the left hand, and the index finger is placed on the wound." While this is an excellent procedure for wounds not easily accessible, it appears unnecessary where a suture can be as easily passed through the wound and be used for both traction and hæmostasis.

After control of the hæmorrhage the pericardium should be carefully cleansed with saline solution. Care should be taken not to handle or touch the pericardium except as absolutely necessary since after cardiac suture pericardial effusion invariably occurs. The muscle and skin are then closed with interrupted sutures, and a drain or soft rubber carried down to the pericardium to allow drainage of the effusion. This is removed forty-eight hours later.

### CONCLUSIONS

(1) The necessity of cardiac suture arises so rarely that some definite method must be at hand if the procedure is to be successfully accomplished.

(2) A simple method of approach and suture is outlined.

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# THE EFFECT OF ARTERIOVENOUS ANEURISMS UPON THE HEART

WITH THE REPORT OF A CASE STUDIED BY PROFESSOR RUDOLPH MATAS,  
DR GEORGER HERRMANN, AND THE AUTHOR \*

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ONE of the serious consequences of arteriovenous aneurisms is the effect upon the heart. My interest in this subject began in 1914, during the course of some experiments which Dr W S Halsted<sup>1</sup> and I were doing to determine the effects of metallic bands applied to blood-vessels. As a collateral branch of this study, we began producing arteriovenous fistulae in dogs to determine their effect on the vessels. We were familiar with the fact that a large fistula between the aorta and vena cava might cause a sudden death of the dog and decided to watch the effect upon the heart of fistulas between smaller vessels. In the course of two to three years we were fully convinced that a fistula between the large vessels of the neck or legs may cause marked cardiac hypertrophy and dilatation and in some instances cardiac decompensation and death. This was shown by teleorontgenograms of the heart, electrocardiograms and autopsies. During these experiments a study of fourteen cases previously admitted to the Johns Hopkins Hospital revealed a very high incidence of cardiac hypertrophy, dilatation and auricular fibrillation, especially in the long-standing cases. In one case, the heart was so bad an operation was not performed. The patient was forty-eight years old, and, although no cause could be found for the cardiac trouble, the aneurism was not suspected of having any etiological bearing. In the literature we found two cases (one axillary, the other femoral) which Osler<sup>2</sup> had watched for fifteen to nineteen years. They both died of heart trouble at the early ages of twenty-nine and forty-six years, without the aneurisms being suspected as the cause. I also learned that congenital or spontaneous communications between the thoracic aorta and vena cava usually led to marked cardiac disturbances, frequently sudden death.<sup>3</sup>

These observations led me<sup>4</sup> to report, in 1920, that I considered arteriovenous aneurisms a very definite cause of serious cardiac disturbances, which might be relieved or cured or prevented by curing the aneurisms. This statement has been abundantly substantiated by the clinical and research studies of Matas,<sup>5</sup> Holman,<sup>6</sup> Leriche,<sup>7</sup> Callander<sup>8</sup> and many others. Holman has produced cardiac trouble in dogs and has cured it by excising the fistula. Many observers have watched the heart of patients decrease in size by temporary occlusion of the fistula and have completely relieved damaged hearts by permanently curing the aneurism.

Before the Southern Surgical Association in 1923, Professor Rudolph

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\* Read before the Southern Surgical Association, December 8, 1931

## ARTERIOVENOUS ANEURISMS AND THE HEART

Matas<sup>5</sup> discussed the effects of arteriovenous aneurisms upon the heart and stressed the fact that the shunting of a large quantity of arterial blood into a vein increased tremendously the amount of work that the heart is called upon to do. Holman, in a series of careful experiments reported in 1923 and 1924, measured the cardiac output with arteriovenous fistulæ open and closed and demonstrated conclusively that the heart does handle an increased volume of blood while the fistula is open. His work has been amply confirmed by others. The amount of this increase is usually directly proportionate to the calibre of the vessels involved and the size of the fistulous opening. In a very recent study of a case which had had a femoral arteriovenous aneurism for six years, Carter Smith<sup>9</sup> showed a reduction of 58 per cent in cardiac output and an increase of 122 per cent in the coefficient of utilization of blood following the closure of the fistula.

As was originally shown by Carrel<sup>10</sup> and Bernheim, a large communication between the aorta and vena cava frequently so overloads the heart that sudden death occurs. Holman occasionally caused sudden death in dogs by the simultaneous production of bilateral fistulæ between the carotid arteries and external jugular veins. In those cases which do not result in a rapid or sudden death, such as when the aorta ruptures into the vena cava, the heart is permanently overloaded until death, or until the fistula is closed.

Although this effect of increasing the amount of blood that the heart has to handle in cases of arteriovenous aneurisms is definitely proven, it is probably not the only cause of cardiac trouble. Except in those cases of sudden death occurring immediately or soon after the production of the fistula, the effects upon the heart from a disturbance to the arterial side of the fistula must be considered. As has been shown by Lewis and Drury,<sup>11</sup> clinically, and by Gage and Herrmann,<sup>12</sup> experimentally, a large arteriovenous fistula produces, in effect, the hydrodynamics of aortic regurgitation. There result a lowering of the blood-pressures, especially the diastolic pressure, an increased heart rate, water-hammer pulse and capillary pulsation. This disturbance of pulse pressure is of special interest to me.

Thoma<sup>13</sup> advanced the idea that a normal pulse pressure is essential to the integrity of an arterial wall. Ney<sup>14</sup> showed that an exceedingly low pulse pressure obtained in the artery just proximal to an arteriovenous fistula, and it is our belief that this is largely responsible for the thinning and degeneration of the proximal artery. In many long-standing cases this vessel resembles more a dilated vein than an artery. It seems rather significant that when there is not a marked dilatation of the proximal artery it is rare to see any serious effects upon the heart. This local effect of a lowered pulse pressure is different from the generalized effect of a markedly increased pulse pressure. I am not prepared to interpret the meaning of these disturbances to the arterial side of an arteriovenous fistula but I cite them in support of my belief that they do play a very considerable rôle in the cardiac disturbances even though they are secondary to the effect of the increased amount of work by virtue of the short-circuiting of blood.

Effects upon the heart, ranging from symptomless slight cardiac hyper-

trophy to extensive cardiac decompensation, have been reported in association with arteriovenous aneurisms. The author<sup>15</sup> has reported a case in which the heart was so completely decompensated that the patient had general anasarca and had been bedridden for six months. During this time he had been treated for cirrhosis of the liver and had had numerous abdominal tapplings with the withdrawal of many litres of fluid. The excision of the fistula relieved completely all symptoms and restored the heart to competency for normal work and exercise. Hoover<sup>16</sup> has reported a similarly striking case.

It would be of very little value to try to determine the incidence of cardiac trouble among the reported cases of arteriovenous aneurisms, for it is only recently that the causal relationship has been definitely established. Even with this knowledge the symptomless cardiac damage is easily overlooked without a careful study of the heart by means of teleorontgenograms and electrocardiograms. That the great majority of arteriovenous aneurisms will sooner or later result in premature death from heart trouble is a fact, however, that should constantly be borne in mind. I am well aware that such a statement is not news to the members of this society. However, my experience leads me to believe that relatively few members of our profession at large possess this knowledge. It is with the hope that a more general dissemination of this effect of arteriovenous aneurisms may result that I take this opportunity of recording another illustration of it. I am particularly pleased to present the following case to this society before which Professor Matas has so often spoken on the same subject, for it is due entirely to his generosity in sending the case to me that I have it to report. In reality, I was only the technician. His exhaustive and accurate studies constitute the major portion of my story.

The case is that of a white man, aged twenty-five years, who had had a femoral arteriovenous aneurism for seventeen years. The communication was in the left thigh just below Poupart's ligament, almost at the exact level of the origin of the profunda femoris artery (Figs 1, 2, 3 and 4). The condition resulted from a gunshot wound with a .22 rifle. For a great many years he carried on the usual work and play of youth without being conscious of any discomfort other than the noise of the aneurism and the increasing varicosities of the leg and groin. Within recent years he had been repeatedly told by physicians that his heart was greatly enlarged. He had become conscious of a disordered heart action, shortness of breath was beginning to be a handicap while exercising, the left foot felt cold at times and frequently "went to sleep", cramps in the calf of the leg were common. He had learned that occlusion of the fistula by manual pressure made his heart feel better and his foot warmer. He had had no swelling of his legs and there was no history suggestive of a cardiac decompensation. He had not been at all incapacitated for work.

This patient consulted Professor Rudolph Matas, August 19, 1930, and I am indebted to him for the privilege of incorporating his studies in this report. Age of patient, twenty-four years, 5 feet, 8 inches tall, weight, 120 pounds. *Diagnosis*—Arteriovenous fistula of common femoral vessels caused by bullet wound (.22 calibre rifle), inflicted sixteen years ago, when the patient was eight years old. The fistula is situated about one centimetre below Poupart's ligament at the base of Scarpa's triangle. In the course of the years that have followed the injury, great varicosities have developed in the saphenous and epigastric tracts. Typical systolic double murmurs can be heard at the vortex of



FIG 1



FIG 2



FIG 3



FIG 4

Figs 1, 2 3 and 4 are photographs of the patient before operation. Note the dilated veins. They pulsed and carried a mixture of venous and arterial blood.

fistula, where the venous hum and roar can be heard with the greatest intensity. The thrill is felt below the fistula, as low down as the knee, and above along the iliac vein and vena cava to the level of the diaphragm. A faint murmur, but not a typical Mākin's murmur, is present at the apex of the heart. The typical Branham<sup>17</sup> bradycardiac syndrome occurs on compression of the fistula—slow pulse and rise in blood-pressure. Pulse and heart-beat before compression, 84. Pulse and heart-beat after compression, 52. There is a marked Hill and Flack sign,<sup>18</sup> as shown by the differential blood-pressure. In the right arm, it is  $\frac{119}{75}$  and rises to  $\frac{125}{75}$  on compression of the fistula. In the right leg (calf), it is  $\frac{165}{30}$  and rises to  $\frac{170}{40}$  on compression of the fistula. In the left leg, without compression of the fistula, it is  $\frac{75}{58}$ . In the left leg, with compression of the fistula, a reading cannot be obtained. The peripheral pulses are faintly felt in the dorsalis pedis and post tibial vessels, disappear on compression of the fistula, but return on prolonged compression when the collateral circulation is well established.

The hyperæmia test shows a return of color, after application of the Esmarch bandage over the fistula, in three to five minutes.

The pyrometer was broken and no electrothermic tests were made.

The electrocardiogram confirms a prolongation of the diastolic pause, with an immediate restoration to normal on compression of fistula.

Professor Matas sent the patient to Dr. George Herrmann for a more complete study of his heart. The report of Doctor Herrmann is as follows:

The patient presents a picture of a long-standing left femoral arteriovenous aneurism with concomitant cardiac changes. It is an interesting fact that the patient had no complaints whatsoever until one shut off his aneurism, when he had a peculiar, short, tight, dyspnoëic sensation in the chest. After one had done this several times, the patient said that he apparently became accustomed to it and had very little sensation when the aneurism was cut off by manual pressure. He had noticed a purring from the very time that he left his bed after the removal of the bullet. He has palpitation on excitement but apparently not on exertion. He has no dyspnoëa under any of the ordinary circumstances and no other symptoms. He has had no œdema, no cyanosis, no syncopal attacks, and, in fact, nothing to suggest that he has had any impairment of his heart muscle.

The physical examination showed a very slight nodding of the head, slight throbbing of the carotid arteries and a considerable pulsation in the subclavian vessels. This was also palpable in the aortic arch of the substernal notch. His cardiac apex was considerably displaced and there was an area the size of a silver dollar in about the centre of the axillary line which pulsated with each rise of the apex. The point of mechanism intensity of the apex beat was apparently in the fifth interspace in the anterior axillary line, eleven and one-half centimetres to the left of the mid-sternal line. There was a shock with systole and a considerable heaving movement about the area. The cardiac area on percussion measured three and one-half to four centimetres to the right and fifteen centimetres to the left of the mid-sternal line. I could hear a systolic murmur over the base which was especially loud in the pulmonic area, and this disappeared entirely with the closing of the communication, just as you had observed. With the obliteration of the fistula, the pulse rate dropped from 88 to as low as 46 and the blood-pressure changed from 114/54 to 118/84. There were throbbing of the fingertips and capillary pulsation.

I made several electrocardiographical studies for long and for short compressions. A compression for one second resulted in a drop in pulse rate from 80 to 50 and the change in the diastolic interval, 0.24 second to 0.80 second and it took about fourteen seconds for recovery, but the diastolic interval of the last beat was 0.28 second. I thought perhaps it would be interesting to compare the varying lengths, so I shall enclose a table (Table I). One other effect noted in the electrocardiograms was the fact that the T-waves of auricular activity became much smaller and were almost erased during the period of compression. The X-rays taken before and after compression of the

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fistula showed the distinctly enlarged heart to be reduced in size at least one centimetre. The films had not been measured when I saw them, I simply superimposed one upon the other.

Our own studies entirely confirmed those made by Professor Matas and Doctor Herrmann. In addition, we made a few observations which I shall include.

In the region of the fistula the veins can easily be seen to pulsate, the pulsation is felt as far down as the knee. These veins definitely carry a mixture of venous and arterial blood. In the prone position there is no collapse of the distended veins unless the fistula is compressed. When the leg is elevated to an angle of 90°, those of the leg slowly collapse while those in the groin and abdominal wall remain distended. The venous pressures were studied by Doctor Louis B. Owens, using the apparatus devised by Eyster.

TABLE I  
*Effect of Varying Intervals of Compression on  
Electrocardiographical Changes*

Length of time of compression	36.3 sec.	17.46 sec.	2.56 sec.	2.4 sec.	1.36 sec.	3.2 sec.	3.3 sec.	3.3 sec.	3.14 sec.
Rate before compression	78	80	90	78	82.5	100	90	99	90
Diastolic interval before compression	0.27	0.24	0.14	0.26	0.24	0.12	0.14	0.14	0.12
Longest diastolic interval during compression	1.06 sec.	0.80	2	0.32	0.82	0.43	0.46	0.32	0.73
Rate during compression	46	50	78	65	45	75	72	50	48
Time of recovery	4	13.92	10.44	-	10.2	8.58	7.38	5.52	9
Recovery to diastolic interval	0.27	0.28	0.14	0.26	0.27	0.14	0.14	0.16	0.14

(1) With fistula open—in a large vein nearby, it is 60 millimetres of water. With fistula open—in a small vein nearby, it is 90 millimetres of water.

(2) With fistula occluded—in a large vein nearby, it is 60 millimetres of water. With fistula occluded—in a small vein nearby, it is 100 millimetres of water. Unfortunately, no venous pressures were taken after the operation.

The surface temperature in the thigh and particularly in the region of the aneurism is definitely elevated, below the knee it is lowered. The temperature of the foot drops very slightly after the application of a tourniquet to the thigh, following its removal there is no rise in temperature above its normal.

A faint pulse can be felt in the dorsalis pedis artery but none can be felt in the posterior tibial. After the fistula has been compressed for two minutes a definite pulse can be detected in both of these vessels, thus showing that there is a well-established collateral circulation.

The artery (femoral and iliac) proximal to the point of fistula is hugely dilated. The abdominal aorta appears to me to be considerably larger than normal.

Careful measurements of the legs do not reveal any lengthening or shortening of the

left leg as a result of the long-standing arteriovenous aneurysm. This was also confirmed by X-ray pictures.

Repeated tests by the patient and by ourselves convinced us that he could easily withstand a permanent closure of the fistula. Between the time of Professor Matas' studies and ours, the patient had practiced occluding the fistula by pressure of his hand, and had reached the point where his heart felt better and he was definitely more comfortable when the fistula was closed. In Doctor Herrmann's studies it is noted that at the first closures of the fistula the patient experienced a "short, tight, dyspnoeic sensation in his chest." With practice these sensations had disappeared, and, instead, he felt better the longer the fistula was closed.

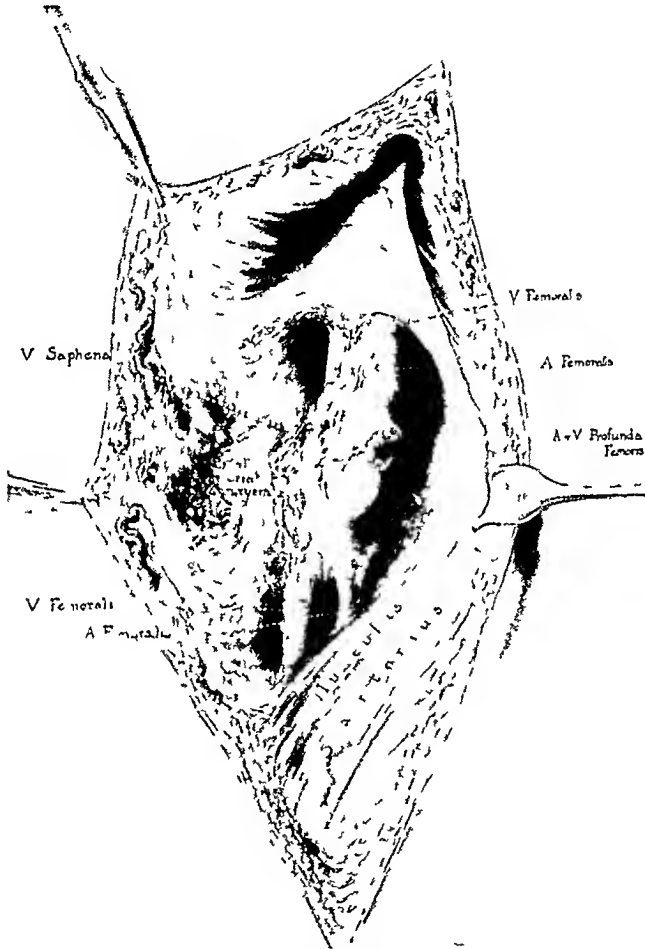


FIG 5.—Illustration made at the time of operation. Note the large size of the proximal artery and the small arterial aneurysm opposite the fistula.

*Operation*—March 14, 1931. Anesthesia: novocaine. Iodine and collodionized china silk technic was used.

Due to the location of the fistula, which was just opposite the opening of the profunda femoris branch, a rather large false aneurysm (Fig 5) where the bullet first penetrated the artery, the extensive scar tissue, and the extreme dilatation and thinness of the arterial wall proximal to the fistula, it seemed to me unwise to try to restore the continuity of the artery. Consequently, I excised the artery and vein as shown in the illustration (Fig 6). At the beginning of the operation the patient's pulse rate was 84 per minute, at the completion of the operation, it was 64.

The operation was relatively easy and was accomplished without any difficulty with hemorrhage. The wound was perfectly dry when we closed it. However, a fairly

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FIG 6—Arteriovenous fistula of femoral vein and artery



FIG 7

FIG 8

Figs 7 and 8 show the condition of the leg one month after operation



extensive hæmorrhage occurred into the tissues on the second day after operation. This resulted in an extensive ecchymosis over the lower abdomen and upper thigh. The hæmatoma was absorbed and the wound healed *per primum* without our having to open

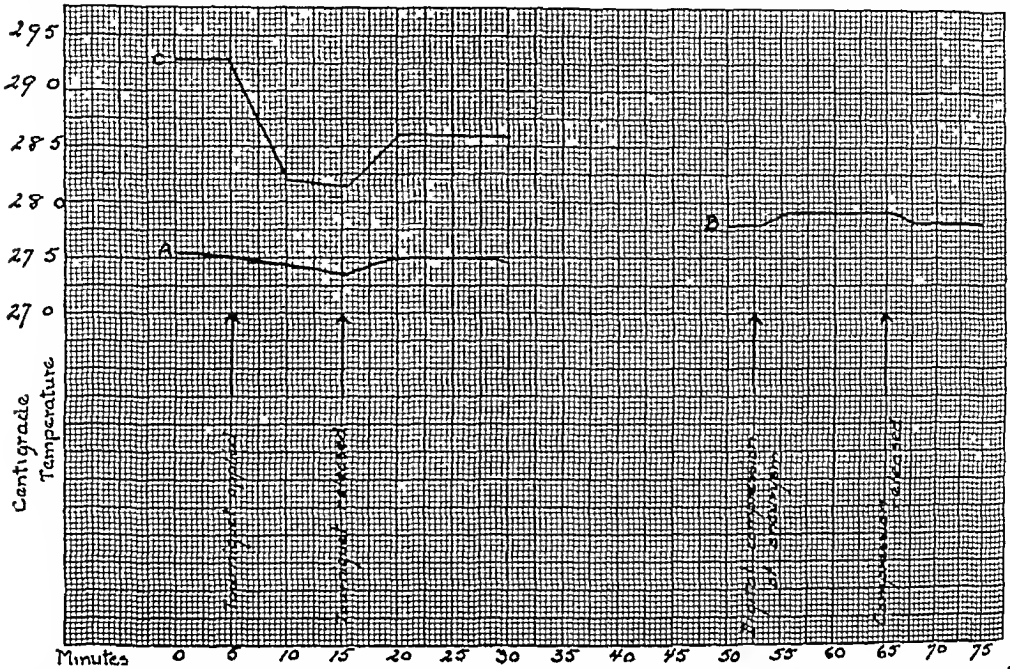


FIG 9—Studies with the thermocouple of the temperatures of the left foot. Note the increased temperature and the normal response to a tourniquet one month after operation. A—Before operation. B—With single compression of the fistula. C—One month after operation.

it. I am at a loss to explain this hæmorrhage unless it was due to a rupture of the vein-like arterial wall. All of the large vessels were transfixed and ligated with heavy braided silk. During the operation the diameter of the proximal artery was noted to be seven-eighths inch, of the distal artery, about one-quarter inch. After removal of the



FIG 10

FIG 11

FIG 10—Teleorontgenogram of the heart before operation.  
FIG 11—Teleorontgenogram of the heart one month after operation.

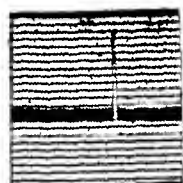
aneurism the communication between the artery and vein measured about three-eighths inch in diameter. The wall of the proximal artery was noted to be very thin and like that of a vein.

At the completion of the operation a pulse could be felt in both the dorsalis pedis

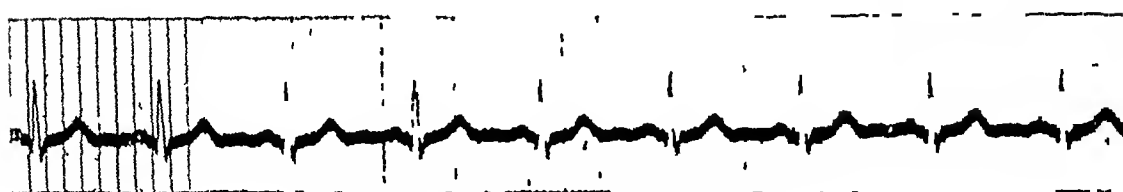
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and posterior tibial arteries (Figs 7 and 8) This pulse remained palpable throughout his convalescence, although at times it was very faint The left foot felt considerably warmer than the right for about ten days after the operation The pulse rate, which was between 80 and 90 before the operation, dropped to 64 immediately after the operation, rose to 80 on the third post-operative day, and then dropped to 70 on the fifteenth day and remained at about this level until the time of his discharge from the hospital

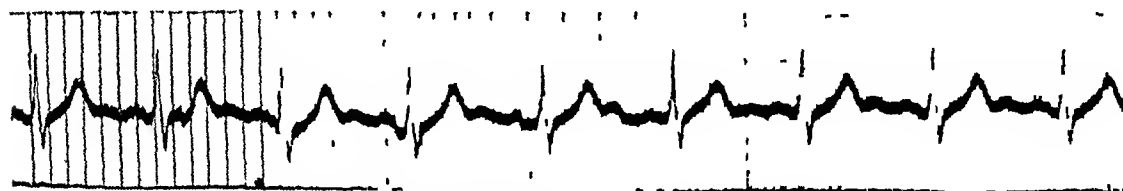
Both feet were studied by means of the thermocouple (Fig 9) before the operation and twenty-seven days after it The right foot gave a normal response in temperature on both occasions following the application of a tourniquet The left foot, before the operation, showed almost no decrease in temperature following the application of the



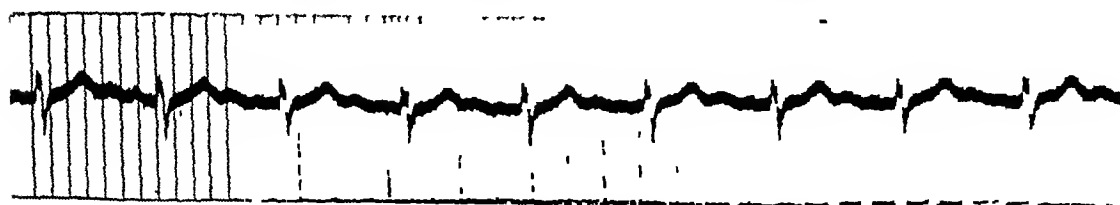
Standardization



Lead No 1—Between Right and Left Arms



Lead No 2—Between Right Arm and Left Leg



Lead No 3—Between Left Arm and Left Leg

FIG 12—Electrocardiogram made before operation

tourniquet, while twenty-seven days after the operation it had risen two degrees Centigrade in temperature and gave the normal response to the use of a tourniquet

Twenty-seven days after the excision of the aneurism the size of the heart was very appreciably decreased (Figs 10 and 11) The retrosternal width at the level of the second ribs was 47 centimetres, the greatest diameter was 11.5 centimetres Before the operation the corresponding measurements were 52 centimetres and 14.5 centimetres The decrease in size of the heart after operation is most strikingly illustrated in the prints of the teleorontgenograms, which were made under exactly the same conditions

*Electrocardiographical Studies*—Dr Johnson McGuire very kindly furnished me with the following data and comments

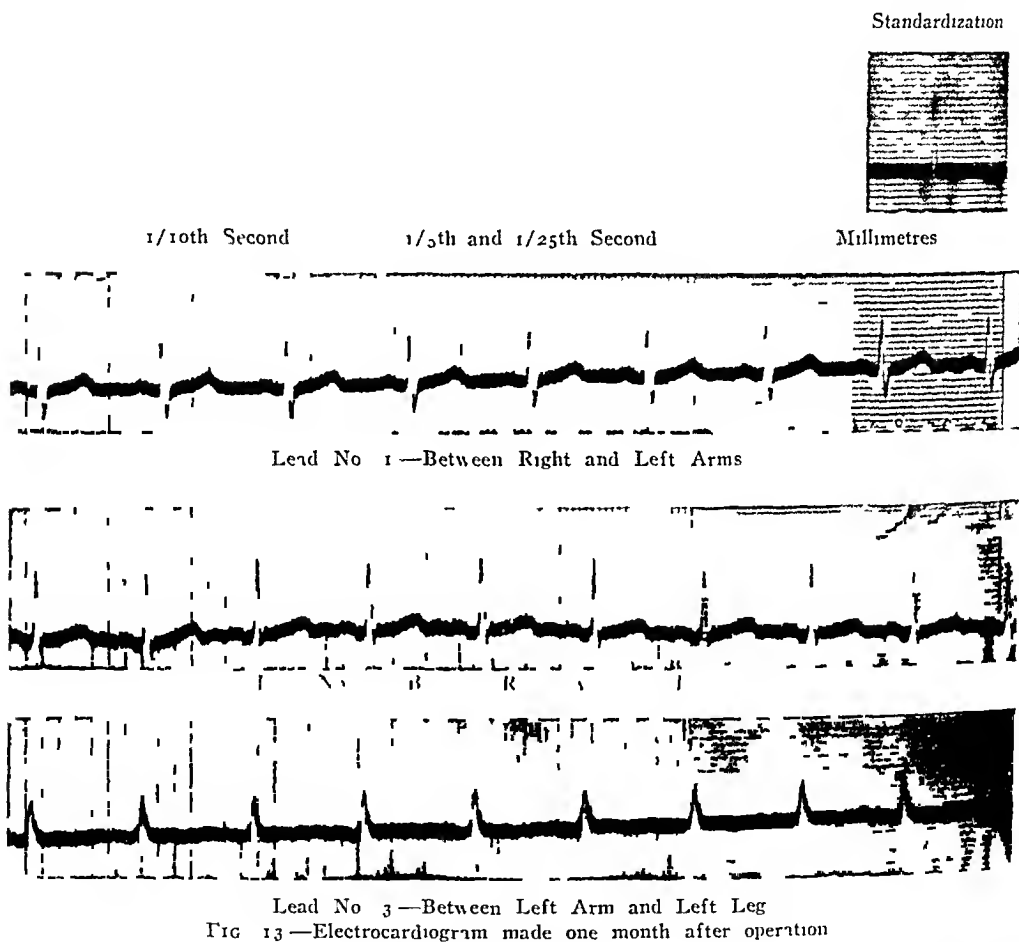
(A) *Before Operation*—(Fig 12) Sinus arrhythmia, tendency to left axis deviation, U-waves present in leads 2 and 3, P-waves abnormal in all leads, diastolic pause 0.22 seconds, rate 90, T-waves measure in lead 1, 2.0 millimetres, lead 2, 3.5 millimetres, lead 3, 2.0 millimetres (B) *After Operation*—(Fig 13) Essentially normal, no tendency to axis deviation, slight sinus arrhythmia, diastolic pause 0.20 seconds, T-waves

lower voltage (lead 1, 1.5 millimetres, lead 2, 1 millimetre, lead 3, isoelectric) than in the pre-operative records, P-waves notched in all leads

There is a relative shift of the electrical axis to the right when compared with the pre-operative records. The T-waves are of lower voltage.

## SUMMARY

(1) Attention is again called to the fact that arteriovenous aneurisms involving large vessels usually affect the heart. The main factor in the causation of the damage to the heart is the increased amount of blood that it has to handle. This results from the quick shunting of a large amount of arterial



blood back to the heart. Another factor which is probably of importance is that there results a condition resembling aortic insufficiency, although the lesion may be far removed from the aortic valves.

(2) A case of femoral arteriovenous aneurism, which had been present for seventeen years, is recorded. It illustrates many of the effects of this condition—cardiac hypertrophy and dilatation, Branham's bradycardiac phenomenon, disturbances of blood-pressure (Hill and Flack sign), changes in the electrocardiogram, pulsating varicosities, dilated and atrophied proximal artery, capillary pulsation, very adequate collateral circulation, etc. Excision of the aneurism relieved completely all cardiac symptoms and caused the heart to return to a normal size.

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(3) This case strongly supports Professor Matas' teaching that the heart should be prepared for the complete closure of the fistula by a preliminary period devoted to temporary occlusions of it. Although the abundant collateral circulation reduces to a minimum the danger of peripheral gangrene, the heart should be considered and partially adapted to the great and sudden change which will follow the operation. An intelligent patient who has practiced temporary occlusion of his own fistula is usually quite certain when it can be permanently occluded without causing any cardiac distress.

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# CANCER OF THE COLON AND OF THE RECTUM

PERSONAL EXPERIENCES FROM 1892 TO 1932

BY JOSEPH COLT BLOODGOOD, M D

OF BALTIMORE, MD

DR T S RAIKORD (J H H , 1930), the Halsted Fellow in Surgery in the Department of Surgery of the Johns Hopkins University, and a special research student in the Surgical Pathological Laboratory of the Johns Hopkins University, has made a restudy of the records, pathological material, and final results of all the cases of cancer of the colon and rectum in the laboratory since the beginning of the Johns Hopkins Hospital in 1889

We were very much helped by the first complete investigation by Dr Paul Preble, in 1907, when a student of the medical department of the Johns Hopkins University Unfortunately, the work of Doctor Preble was not published, as he could not finish it Doctor Raikord's studies are in preparation for publication

The subject was selected by me chiefly, because, from my own recent experience confirmed by Doctor Raikord's investigation, there are still unsettled problems in the operative technic of resection and the type of suture, especially when the cancer is situated in the transverse colon or rectosigmoid colon

In addition, these studies demonstrate the importance of the gross and microscopical pathology of each individual case and the fact that the record of each individual case is of little value except for the study of post-operative mortality, unless the patient is traced up to the time of death or is known to be well five or more years after the operation

The study of these records again demonstrates one of the fundamental facts in the clinical research of cancer cases, and that is *The ultimate cure depends chiefly on the stage of the local malignant disease at the time the operation is performed*

It also shows clearly another fundamental fact The surgery of cancer was conceived and developed when the majority of cases of cancer came into the hands of operators when the local disease had become practically inoperable Nevertheless, these early pioneers were able to demonstrate the truth of their conceptions of the proper operative technic, because, largely on account of accidental factors, patients came under observation first in operable stages, although still incurable on account of metastasis, and later in the operable and curable stage

When I became associated with Doctor Halsted in 1892, one year after my graduation from the University of Pennsylvania, Billroth, of Vienna, had established the surgical technic of resection of the stomach and the suture of

end-to-end and lateral anastomosis, and Kraske,\* in 1885, had ranked with Billroth in his contribution to the technic of resection of the lower end of the rectum, and had discussed the difficulties of the approach to the removal of cancer in the rectosigmoid colon too high for removal from below through the huge sacral wound made possible by the removal of the coccyx and a small piece of the sacrum

William J Mayo, in 1912, gave the best review of the literature of the surgery of the rectosigmoid colon from the time of Kraske to the date of his article. The majority of contributions since 1912 have had largely to do with substitutes for the Kraske operation and the safest handling of cancer in the rectosigmoid area

*Brief Historical Review*—When I entered the surgical clinic of Doctor Halsted, in 1892, there were a number of cases recovering from the Kraske operation for cancer of the rectum. One of them I was assigned to dress. This patient belonged to the operable, but incurable group on account of metastases. He lived almost four years in comfort and died of metastasis to the liver, after an illness of less than two months.

The first operable cancer of the rectum, therefore, occurred about 1892. The first operable cancer of the colon was situated in the sigmoid, was resected with successful end-to-end suture by Doctor Halsted in 1902, lived six years and died of metastasis to retroperitoneal glands. The first cancer of the rectum to be cured permanently by a complete Kraske operation was in 1900. This patient lived to a good old age until 1929. Within about three years after operation almost complete control of defecation was accomplished. She wrote me somewhat as follows: "You will be glad to learn how well I am. I am not only able to go to church, but to sit with comfort and without fear of an accident through my husband's sermons, and he has a reputation for being a 'long' preacher." This fortunate result in function after a Kraske resection is noted by Kraske himself in 1885 and all the literature since then.

I am not sure that any of the so-called modifications of the Kraske operation in the management and formation of the sacral anus have much to do with the improvement in function beyond the fixation of the lower end of the rectum, so that there is no prolapse of the mucous membrane, and the surrounding skin heals so that it reduces the actual opening into the bowel. I have frequently seen this take place when the entire healing was by granulation. Apparently good function is more a matter of luck than of management after this operation.

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\* In Kraske's article in the *Archiv für klinische Chirurgie*, vol. xxxiii, pp. 563-574, 1885, he pictured a technic of the complete excision of the rectum for high carcinoma in which he removed the coccyx and a piece of the sacrum, all the glands, and usually opened the peritoneal cavity and brought down the sigmoid and fixed it in the sacral wound. In my opinion, Kraske's relation to the complete operation for cancer of the rectum is the same as Halsted's complete operation for cancer of the breast, Billroth for resection of the stomach, and Wertheim for the radical operation for cancer of the cervix.

There seems no question as to the explanation of the larger number of cures after resection for cancer of the left colon, especially of the sigmoid rather than of the right colon, especially of the cæcum, which is most accessible. In the earlier years, it was obstruction—and usually acute obstruction—that brought the patient to the surgical clinic. The first operation was colostomy, the second resection. The explanation of this is that the fecal matter in the left colon is solid and in the right colon, especially the cæcum, liquid.\* The first permanent cures after the complete resection of the right colon for cancer of the cæcum were accomplished in 1910, eight years after the first five-year cure, in 1902, of a cancer of the sigmoid. The first permanent cure of a left-sided cancer of the colon was in 1904.

When one studies critically the records, the fact that strikes one first is the large per cent of clinically inoperable cases, the small per cent of cases in which any attempt was made at an exploratory laparotomy or an operative investigation of the cancer of the rectum, and the very slow progress of cases in which the local growth could be removed. In these so-called operable cases, in the beginning, among those who survived the more extensive operation, practically all died of metastasis to neighboring glands or remote organs within five years. Then there were a few who lived more than five years and still died of metastasis. There was nothing in the clinical history, except a slightly earlier intervention that differentiated the operable cases in which the patients survived ten to thirty years, from the operable lesions who died within ten years of metastasis. Even when we studied the microscopical pathology of the cases that died ultimately of internal metastasis from those who lived more than ten years and had no symptoms of metastasis when they died, we cannot always distinguish the cured case from the morphology and arrangement of the cancer cell. If the neighboring lymphatic glands in cancer of the stomach, colon and rectum are microscopically involved, there is rarely a permanent cure, although there may be a few temporary cures of five or more years. Now that cancers of the stomach, colon and rectum are coming under observation more frequently in the earliest stages of the disease, that is, within the shortest interval of time after the first symptom, we are more frequently able to grade the malignancy of the local growth and pick out those whom we expect to die shortly of metastasis. There seems no question that in the earlier years these grade III and IV tumors either died of metastasis without entering a surgical clinic, or were so distinctly inoperable when they entered the clinic that no tissue was obtained.

In addition to a great increase in the number of early cases of cancer of the colon and rectum, we are beginning to observe, as we also do in the stomach, more benign lesions, most of which suggest that they are the local lesion

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\* Doctor Raiford agrees with me that obstruction is a more common symptom in cancer of the left colon, especially in the region of the sigmoid. He also agrees with the fact that the fecal material is more solid in the left colon. He, however, suggests one other factor, decrease in size of the lumen of the colon, and reminds me that William J. Mayo has called attention to this factor.

## CANCER OF COLON AND RECTUM

that precedes cancer. The majority of these are papillomas, usually single. There is another remarkable suggestive observation—as the number of cases of cancer of the colon subjected to operation in the very earliest stages increases and the number of those who live five or more years also increases, we observe, first, that after three to five years more patients return with cancer in some other part of the colon. In my first case the malignant tumor first removed was situated in the rectosigmoid colon. The method was by the abdominosacral route, or the so-called combined resection, and a very fortunate recovery followed an end-to-end suture in the sacral wound from above and the placing of the anastomosis extraperitoneally by the suture of the peritoneum in the floor of the pelvis to the mobilized sigmoid colon above the suture line. This patient made an excellent recovery and nine years later survived a resection of the right colon for a chronic obstructing cancer of the ascending colon. Unfortunately, he succumbed to a chronic nephritis some six or eight months later. Then we began to observe patients returning at different intervals with benign polypoid tumors. This has occurred most frequently on the left side in the region of the rectum, rectosigmoid and sigmoid colon.

On a few occasions, in resecting a distinct cancer of the colon, we would also observe and remove a benign polypoid tumor.

This brief historical review is given chiefly to indicate that at the present time the most important factor in increasing the number of benign lesions of the stomach, colon and rectum and of operable curable lesions, rests upon educating more and more people to the protective value of selecting a physician while they are well and—perhaps just as important—seeking the advice of this selected physician while well, cultivating the habit of periodic surveys and—even just as important—seeking the advice of that physician the moment there are any signs or symptoms which were not present at the last preceding periodic examination.

My more recent studies, in spite of adverse opinions of many of my colleagues, indicate that the chief cause of the failure to cure cancer today cannot be placed on the fact that the first physician failed in making the proper examinations or failed to refer the patient to a physician who could make it. Undoubtedly, this factor is present, but it is not the chief factor.

It is quite true that many surgeons with insufficient experience in the resection and suture or in the entire management of the pre-operative, operative and post-operative care of lesions of the stomach, colon and rectum, reduce the chances of their patient's permanent cure by too high an operative mortality. But this in itself is not a significant factor as compared with the

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\* Doctor Raiford agrees that in all the old histories and in many up-to-date ones the chief factor in late or inoperable cancer is that the patient delays in seeing any doctor. He also calls my attention to the fact that even today among the internes in the hospital wards rectal examinations are still neglected. In my clinic I am seeing more and more patients who have reported to their family doctor at once after the first symptom and their physicians have made the proper rectal examination or referred their patient to one more familiar with the diseases of the colon and rectum.



fact that the patient neglects periodic examinations and procrastinates from ignorance or fear or embarrassment when the first symptoms appear

*Clinical Features*—The vast majority of patients with single or multiple tumors of the colon, including the rectum, or with the earliest stage of a local growth which has assumed a malignant character, have definite warning symptoms of sufficient character—providing the individual is properly informed, has already selected his family physician and has had at least one diagnostic survey—to give him ample time to be examined when the disease is either still benign or in the operable curable stage. Neither the profession nor the public realizes or subscribes to the truth of this statement

The warning most readily recognized is blood in the stools. Then there are repeated attacks of colicky pain, with and without diarrhoea or blood in the stools, with no explanation, such as indiscretion in diet. Then there is a sudden or gradual constipation requiring cathartics, unusual vague sensations within the abdomen, discomfort from tight clothes or belt when bending over. Everyone seems aware of the symptoms and an increasing number are being informed of the importance of these warnings. Obstruction is a late symptom. On the left side, especially when the lesion is in the sigmoid, this obstruction may appear early enough to save the life of the patient. It never does so when the malignant tumor is on the right side. Cancer in the mid-transverse colon<sup>\*</sup> may cause only gastric symptoms. In one of my cases the gall-bladder was first drained for the symptoms. Three weeks after operation there were recurrent symptoms. The clinical picture impressed me as one of pancreatitis. When I explored the abdomen, there was no fluid and no fat necrosis. When I lifted up the omentum to examine the pancreas I found an annular obstructing mass, small in size, in the transverse colon. It was immediately resected to be followed by an end-to-end anastomosis. The patient lived more than fifteen years and died of other causes. One could write pages on the slight variations of the warnings or the symptoms described by these patients. It seems unnecessary and not helpful, at least as yet, to attempt to classify them. Cancer students all know that there is no difference between the warnings of a local lesion not cancer and a local lesion not cancer but which ultimately will be cancer—for example, a polypoid growth—and the local lesion which is cancer. This is fundamental for a local lesion in any part of the body, external and internal. It is this that makes differential diagnosis difficult in spite of modern diagnostic methods. It is the possibility of cancer that urges the necessity of periodic examinations and a thorough examination immediately after the first warnings

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\* Doctor Raiford asks me why cancer of the colon may often have gastric symptoms only. He is inclined to explain it by the fact that the tumor itself in cancer of the transverse colon may involve the stomach. I have just read two histories in which the cancer of the colon was confined to the colon only, in addition, there was no hydrochloric acid in the gastric juice. He will go into this in detail in this paper. Therefore, it is always a good plan when the stomach is explored for gastric symptoms to examine the transverse colon, and *vice versa*. It would be difficult to distinguish colic in the transverse colon from colic in the stomach, and gastric secretion is very much influenced by pain

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*Routine Examinations*—The chief risk lies in curtailing the examination, or stopping the moment something definite is found. Remember, lesions of the colon may have only gastric symptoms and now and then gastric lesions may have symptoms referred to the lower abdomen. Very frequently, lesions of the gall-bladder have no distinct signs or symptoms referred to the right upper quadrant. The examination should begin with a rectal examination in men during which the prostate should not be overlooked, in women, combined with a pelvic examination. In both, proctoscopic inspection should follow. The sequence of the fluoroscopical study and X-ray films of the colon after bismuth by enema and investigation of the œsophagus and stomach with fluoroscope and plate, and examination of the gall-bladder, and a plate of the abdomen for stone in the kidney or elsewhere, varies with the clinical picture. There is the least danger of overlooking a lesion or coming to an erroneous conclusion when the gastro-intestinal study is complete. For example, here is a case diagnosed and treated for gastric ulcer, when there was really a stone in the right kidney. Here is another where the diagnosis of cancer of the transverse colon was made from one picture after a bismuth enema. The surgeon who explored failed to find a cancer of the colon, but on account of induration of the pancreas naturally concluded that there was a cancer of the pancreas, and as there was no jaundice, did nothing. The patient died five days after operation from hæmorrhage. The autopsy revealed a non-malignant ulcer of the duodenum.

Even in the most experienced hands, it is often difficult to carry on a complete pre-operative investigation, and often operation is decided against without such a complete study.

*Can a routine complete examination overlook a cancer of the colon?*—Yes, when the lesion is situated above or beyond the visibility of the proctoscope. In some instances, it is justifiable to explore the colon, just as we explore the appendix, on the clinical picture only. The danger of overlooking a cancer of the stomach is much less. Balfour told me that they had one case in The Mayo Clinic during a visit some years ago. I have just had my first personal experience. Two of my associates, independently, after a complete gastro-intestinal study, rendered negative reports. Three months later the reports were positive. An operation confirmed the correctness of the second diagnosis.

I am gradually coming to the opinion that it is not an unnecessary precaution to make a complete gastro-intestinal study in a diagnostic survey or as a part of a periodic examination, even when there are no abdominal symptoms, just as I think it is a good plan to use the electrocardiogram as part of a complete diagnostic survey or periodic examination when the ordinary physical examination of the heart is negative. We do not now depend upon the physical examination of the chest alone, we always take an X-ray of the chest or should do so.

Recently I made the statement in a number of my publications that it would add to the value of an investigation by a urologist to use the proctoscope. The same is true of the pelvic examination of women.

To increase the number of cures of cancer of the rectum and colon, we must give proper information to more people—persuade the medical profession to make more complete examinations. The evidence before me suggests that this is really more important than the reduction of the operative mortality. This mortality is relatively low in operable lesions, except after operations in the rectosigmoid area, which is high even in the most experienced hands. I am of the opinion that when a surgeon of less experience finds such a tumor in the examinations and there is no urgency on account of obstruction, he should refer such a case to a surgeon of much larger experience. As a matter of fact, they are well known and easily gotten at.

When such an unfavorably situated lesion of the colon is discovered at the exploratory laparotomy for obstruction, my advice is to do an appendicostomy which relieves the obstruction at once and leaves the operative field intact for the more experienced operator. If a colostomy is to be performed, it should be made high, at the junction of the sigmoid and ascending colon.

*Intestinal Suture*—I was quite familiar with Senn's experimental work on end-to-end and lateral anastomosis with the decalcified bone plate when I was a pre-medical student at Wisconsin. At Pennsylvania, in the physiological laboratory of Professor Reichert, my classmate Hillier and myself performed many intestinal sutures of all types, using rubber bands instead of decalcified bone plates. However, never before my visit to Johns Hopkins, in 1892, did I see an intestinal suture performed on a human being. My first introduction was a gastroenterostomy for cancer done by Professor Halsted. He used the posterior route, retrocolic, a rather long loop. He used a single row of mattress sutures. His operation was entirely based upon his remarkable experiments on dogs. This work was done in Welch's pathological laboratory between 1884 and 1889, previous to the opening of the hospital. I know of no more perfect piece of anatomical work than this of Halsted's. It was he who demonstrated the value of the submucosa, he objected to the Lambert stitch, because it did not catch the submucosa. I am inclined to think that Lambert did catch the submucosa, but that he did not know it.

However, the great and dominating publication was that of Billroth, before 1885, that was shortly before Halsted's work. The English-reading student depended upon the Sydenham translation and the remarkable illustrations. These pictured the end-to-end anastomosis and the three rows of single interrupted silk sutures, the inner including the mucous membrane, the two outer not including the mucous membrane. Billroth made no mention of the value of the submucosa. He also pictured and described gastroenterostomy. Later Kocher developed his method of end-lateral suture after resection of the stomach. Then there were various changes in gastroenterostomy, anterior and lateral, with the final development of the Polya suture. Finney's remarkable pyloroplasty was developed before and after 1900. He accepted Halsted's mattress suture, did not employ a mucous-membrane suture, but did not depend on one row only.

What I want to emphasize is this Intestinal suture was really established by Billroth Certain details were later learned, especially in the suture of the large gut, which is more difficult than the small gut or the stomach The difficulty in the suture of the large gut is that its circulation is not so good as that of the stomach or of the small gut, and the danger of perforation is due more to necrosis than the faulty suture End-to-end anastomosis is more difficult in the colon than in the small intestine or between the duodenum and the stomach The majority of operators have returned to the Billroth I operation on the stomach, which is an end-to-end anastomosis, but the majority of the same operators prefer the lateral in the small and always in the large intestine

It has always been my opinion that operators, not only in their experiments on animals but in the actual operative technic on the human being, have exaggerated the danger of leakage My great chief, Halsted, up to the time of his death, was working on dogs for a successful aseptic suture and he left us the remarkably conceived buttress suture, which is rarely employed even by his associates It would appear to be chiefly applicable for end-to-end suture in the bottom of the pelvis after the resection of a rectosigmoid lesion From my experience, it is less difficult to do the suture with ordinary small clamps without the more difficult measures as originated by Halsted However, this still must remain a personal question with the operator The extra danger in the most expert and experienced hands of resection and end-to-end suture of a cancer of the rectosigmoid area is so great in some cases that it seems wiser after resection to invert the lower end, close the peritoneal cavity over it, and do a high colostomy My first successful case was in 1904

*Mikulicz' Method*—Many experienced operators even today, including Rankin, of The Mayo Clinic, follow this safer procedure in some cases of cancer of the colon It adds unnecessarily to the time in the hospital and to the discomfort of the patient, and should be done only as a life-saving procedure

In 1909 (*ANNALS OF SURGERY*, vol lxi, p 161, February, 1909), I reported and illustrated a modification of Mikulicz' method and a modification of the lateral anastomosis between the ends of the colon after a resection of a piece of the colon (Figs 17, 18, and 19) The first operation by this technic was performed in 1906, and has been done on frequent occasions since

The object of this suture is to prevent danger should there be a leakage in the inserted end of the large intestine Every operator has experienced this distressing post-operative occurrence, which practically always ends in death With few exceptions, the ends of the colon after resection can be brought together in this way and sutured into the peritoneal wound so that if any leakage takes place it will drain extraperitoneally At my last resection a few weeks ago of a cancer of the transverse colon there was sufficient colon to allow any method of suture There was a great temptation to do an end-to-end anastomosis The patient had had no obstruction and the pre-opera-

tive preparation had been complete. The colon was empty. The patient was in good condition. Nevertheless, I chose the safer suture, as there was no tension. The only variation in technic was the employment of continuous catgut through the mucous membrane. The inversion was made with two rows of fine black silk. There was leakage on the tenth day, but the external wound had been drained. This complication prolonged the convalescence but the time was much shorter than if I had used the Mikulicz method.

*Method of Inversion of the Colon*—When one resects the small intestine and decides on a lateral anastomosis, the ends of the small gut can be ligated with catgut and inverted with interrupted sutures of fine black silk. Some operators use catgut throughout. This method is not safe for the colon. The mucous membrane may not be properly caught by the ligature. It is my method to leave the small clamp on, close the mucous membrane with interrupted fine black silk, then place the first row of sutures through the wall of the gut over the clamp, withdraw the clamps, and invert the mucous-membrane row and then place at least a second row of fine black silk.

*Resection of Cæcum and Right Colon*—Halsted, in 1893, resected a piece of ileum and cæcum, brought the two ends out and sutured them in the wound, but the patient died some weeks later and the autopsy showed cancer throughout the abdominal cavity. In 1894, Finney resected the ileum and a portion of the cæcum for a tumor in the ileocecal valve, producing chronic obstruction. He then made a lateral anastomosis. There was a leakage from the inverted end of the large gut, but fortunately it escaped extraperitoneally and the patient recovered. This patient was followed for more than twenty-five years. The tumor, however, proved to be benign.

Before I had my first resection for cancer of the cæcum in 1911, I learned from Dr. William J. Mayo his method of mobilization of the right colon, preliminary to its resection. It facilitates matters to mobilize at least six inches of the terminal ileum. Rankin, in his recent monograph, agrees with him. One opens the peritoneal cavity at the outer border of the right rectus. If necessary, this wound can be enlarged outward by a lateral separation of the lateral muscles. An incision through the right rectus does not permit the same facility to enlarge the wound, and one is apt to be bothered with the deep epigastric vessels. After orientating the mass and examining the mesentery for glands and deciding that it is operable, even if there is metastasis to the liver or to inaccessible lymph-glands, I believe the patient is made more comfortable for the time he has to live by resection than the side track anastomosis. In the first place, palpable lymph-glands do not mean involved glands. In the second place, it is difficult to palpate and impossible to see the liver from this low wound.

The cæcum, the appendix and the ileum are lifted up. The outer peritoneal fold of the mesentery of ileum and cæcum are divided with the knife and separated by blunt dissection as near as possible to the gut, but a good distance from the involved area. This peritoneum is nicked and separated along the ascending colon up to the point where the colon is to be divided. If

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one plans resecting the entire colon, carry this mobilization up until the hepatic colon is mobilized. Then one lifts up the ileum and colon, finds and divides the vessels in the inner fold, again saving as much peritoneum as possible. This is done in order to cover the raw surface left by the removal of the large gut. If there are any palpable glands, remove them with as wide a margin as possible, or one can remove a gland with the cautery and make a frozen section. If the gland is involved, proceed to the limit of glandular removal, if it is not involved, do not sacrifice so much peritoneum of the mesentery.

The question is as to how to ligate the vessels. My experience urges clamping the vessels, dividing between the clamps and ligating, either with fine silk or 00 chromic catgut. In experiment on dogs one can ligate these vessels with a straight intestinal needle, threaded with fine silk, and have no difficulty, but on the human being it requires more tension on the ligature to stop bleeding than the method of clamping first. It is difficult to prove, but my impression is that there have been fewer cases of embolism from the ligated mesenteric vessels and even the omental vessels if they are clamped and tied rather than ligated without clamping. Also, the ligature is less apt to slip than when tied over a clamp.

There is really nothing difficult in the resection of the entire right colon. It takes a little more time if it is carried to the mid-colic artery in the transverse colon, but there should be no more mortality. I began with my first case in 1911 (Fig 16) by making a complete resection to the middle colic artery. Since then, except on few occasions, I have resected distal to the tumor, selecting a good vascular area, as shown in Fig 16 at X. It makes no difference where you divide the colon, the most important thing is circulation. The next is proper inversion, as already described. It seems to make little difference how you anastomose the ileum to the colon. I have never selected end-to-end. I have usually chosen lateral with the two ends pointing out and have frequently brought these two ends out, as shown in Fig 19. But when the rent in the right peritoneum cannot be sutured, instead of leaving a huge raw surface there I have risked the leakage from the inverted end of the colon and sutured the colon into the rent. But when this is done I always suture the ileum over the inverted end of the colon. So far, fortunately, there has been no leakage. It is interesting to note that I have learned very little in the technic of the resection of the right colon since the experience of my first case in 1911, and at this time I was greatly helped by Mayo's article and Halsted's experimental work on dogs in preserving the circulation of the divided end of the gut.

*Apparently Inoperable Cancer of the Right Colon*—In one instance, an operator of experience explored because of a palpable tumor in the right lower quadrant and decided that the condition was inoperable. In one (Ballou, Path No 15,788) the operator (1914) anastomosed the ileum to the transverse colon. Later, by immobilization of the right colon, I could demonstrate that it was adhesions and not new growth that impressed the

first operator that the colon could not be removed with the cancer, and the palpable glands were not metastatic. In this case it was necessary to remove the colon to the mid-colic vessels. I examined this patient a few days ago (1932). There are no signs of local recurrence or metastasis. He still now and then has slight attacks of diarrhoea. This is the objection to complete resection of the right colon for cancer unless it is essential to allow a more complete removal of the disease. The more of the right colon you remove from a patient with malignant disease, the greater is the risk of an annoying post-operative diarrhoea.

It is remarkable that when you resect the same amount of right colon for ptosis, as advocated by Lane, of London, you do not observe this diarrhoea.

*Chronic Inflammatory Tumor of the Cæcum*—Doctor Sowers, Resident Surgeon of the Johns Hopkins Hospital, explored a tumor of the cæcum in 1905, decided it was inoperable, removed no tissue for microscopical diagnosis. This patient was traced for nineteen years and we then were informed that she died of other causes. Such observations are of great importance when we estimate the cures of real cancer. Had this patient been treated after she left Johns Hopkins Hospital by some cancer cure the public could have been informed that the diagnosis of inoperable cancer had been made after an exploratory operation in that hospital.

When the tumor is situated in the hepatic flexure or right colon and its proper resection would force an end-to-end anastomosis, it is my opinion that the safer procedure would be a complete removal of the right colon with the safer suture of ileocolostomy. If, however, one can resect and suture by the lateral method, or my method, it might be wise in some instances to choose this way. I am confident that my patient operated on some weeks ago for a cancer in a very redundant right colon in which I chose local resection and lateral anastomosis by my method, would have run no more risk and saved much time and money had I performed a complete resection of the right colon.

*Cancer of the Mid- or Transverse Colon*—The personal experience of any single surgeon is limited. Doctor Raiford found, as I know, and as most experienced operators know, that the mortality after resection of the transverse colon with any form of anastomosis other than the method described here by me has had a too high mortality. Part of this may be explained by improper pre-operative preparation, that is, failure to have a clean colon. Perhaps some of the mortality could have been eliminated by a pre-operative appendicostomy, which I am now employing with few exceptions in every case of resection of the colon itself in which the cæcum is not removed. It is an operation that can be done under novocaine. It relieves obstruction if it is present. It also shortens the time of pre-operative preparation. In my own case of end-to-end anastomosis of the transverse colon I placed the suture extra-peritoneally by putting the omentum behind it and suturing the gut on each side of the suture line to the peritoneum of the abdominal wall. This patient recovered in spite of a slight leakage. I had no choice in this instance. I have mentioned the case before. The patient was acutely ill following the

drainage of the gall-bladder. The transverse colon seemed too short even to allow a Mikulicz. I could give the palpable disease but a very narrow margin, and the suture had to be done under some tension.

It was the study of the pathology in this case and the ultimate good result that first impressed me that operators gave malignant disease of the colon too wide a margin. This is unnecessary. The place to give a good margin is the mesentery with the glands. In both stomach and colon the advice to give wider margins is based upon pathological studies of practically hopeless cases and is not confirmed by recent pathological studies in my laboratory. Doctor Raiford is now at work on the confirmation of this statement. So far, he has found nothing to indicate that this statement is not correct.

*Cancer of the Splenic Colon*—The difficulty here is the mobilization of the colon. It can't be done in the usual way without too big a wound. In my few cases I have ligated the vessels first and then gone through and divided the peritoneum on the other side. Many of these cases become inoperable quickly on account of adhesions. A few come under observation with acute obstruction. One, I remember especially, of a colleague of mine, who, operating for acute obstruction, found the descending and sigmoid colon collapsed and the left transverse dilated. With the hand he could feel up to the splenic flexure a small tumor with a ring-like contraction. Looking upon it as benign, he anastomosed the left transverse with the sigmoid colon. Four and a half years later the patient, up to this time free from all symptoms, developed the signs of an abscess in the splenic area. When I explored it, it was a broken-down carcinoma due to the invasion of the original cancer in the splenic colon.

*Cancer of the Descending Colon*—This is a rare situation almost as difficult to mobilize as the splenic colon and more difficult to suture. I have not had sufficient experience to justify any advice as to methods. I would recommend appendicostomy whether there is obstruction or not. I would mobilize the bowel in the position of the cancer above and below and if possible bring out the colon with the tumor after the method of Mikulicz and then employ my suture. If this could not be done, and I was not certain of my end-to-end anastomosis, or if there was too much tension for end-to-end anastomosis I would bring the two ends out at separate places in the wound, suturing a tube in the upper and closing the lower. If the patient was not in good shape, I would postpone an anastomosis between the sigmoid and the transverse colon. I trust that Doctor Raiford's paper will ascertain the cause of the large mortality after resection of cancer in the mid, transverse, splenic and descending colon.

*Cancer of the Sigmoid Colon*—This is one of the most common situations, and if the sigmoid is redundant there should be no difficulty in mobilization and proper resection. The difficult question to decide is the method of suture, when there is a choice other than end-to-end. There is no question that the method of Mikulicz in bringing the tumor out and making the lateral suture with two ends out recommended here, has the least mortality. Yet Halsted,



in 1902, in his first operable case of sigmoid cancer, made a successful end-to-end suture after resection. The patient lived in comfort six years. I had a similar successful resection and end-to-end suture in 1906. Almost every operator of experience has had similar success. But I am not convinced that end-to-end suture is safest here or should be the suture of choice rather than the suture of necessity. I would also recommend, as already mentioned in this paper, preliminary appendicostomy.

*Sigmoiditis and Diverticulitis*—Not infrequently these two benign lesions of the sigmoid colon may give rise to identical symptoms. Even the study of the fluoroscopical picture and X-ray film may simulate cancer. When the abdomen is explored, whether there is obstruction or not the mass to be palpated may feel and look like cancer. These non-malignant inflammatory lesions will even suggest inoperable cancer and it is fortunate for the patients when they are apparently inoperable because they recover from the colostomy and live for many years, long enough to exclude cancer, and in the majority of instances the colostomy closed spontaneously or can be closed. If the patient is very stout and a bad operative risk and the lesion of the sigmoid difficult to remove, it is wiser to do a high temporary colostomy first. At the second exploratory laparotomy the inflammatory lesion may show such changes of improvement that its benign character can be recognized. My records show that in recent years the majority of these inflammatory lesions have been recognized and at least resection has not been performed on very difficult cases with fatal results.

*Cancer of the Rectosigmoid Colon*—To accomplish a successful resection, with or without restoration of the continuity of the bowel, has been a difficult problem and still is. Even Kraske, in 1885, gives considerable space in his article to the difficulty of removing through the sacral route cancer in this region. In *Surgery, Gynecology and Obstetrics*, for August, 1906, I reported my first successful case of resection of a cancer in the rectosigmoid area by the so-called combined abdominal and sacral route. In addition, I was able to restore the continuity of the bowel by a suture of the end of the mobilized sigmoid brought down the abdominal cavity to the remaining half of the lower rectum, which had been undisturbed in the resection. This patient was ideal for this type of operation: very thin and wiry, and a good operative risk. I have already mentioned that this case, some nine years later, recovered from a resection of a similar cancer in the right colon, and then died a few months later of nephritis. In 1920, I fortunately had a similar successful case. This patient was also a good operative risk and had a redundant sigmoid. This patient is well in 1932 and until very recently was a railroad engineer.

In spite of these two fortunate experiences, I have not tried this operation in the last ten years, and I gather from the literature and the experience of my colleagues that a very few if any are taking this added risk of restoring the continuity of the bowel.

Tumors in the rectosigmoid area should first be explored, and I prefer

preliminary appendicostomy under novocaine. At the second operation, one must decide if it can be done from above alone. There are two methods. Divide the peritoneum around the rectosigmoid and isolate the gut and if possible divide, suture and invert the gut below the tumor. Then remove the colon with its mesentery and glands until you reach the proper position above the growth. Then divide the sigmoid colon again, remove the colon, and make a colostomy.

When this cannot be done, we have a choice between the combined removal by abdominal and sacral route of the mass in the rectosigmoid, or the division of the sigmoid colon above the mass and the isolation of the mass below and the suture of the peritoneum above it, and the making of a colostomy of the upper sigmoid loop (method of Robert C. Coffey, of Portland, Oregon). My personal experience so far leads me to prefer the Coffey method in cases of this kind. My first case, which was eminently successful nine years ago, is living today.

*The Method of Miles, of the Cancer Hospital, London*—In the hands of this dexterous and widely experienced surgeon, the mortality has been extremely low. Personally, I cannot accept his method for my cases. Remember, Miles, by the combined abdominal and sacral route, removes the rectum from anus to sigmoid irrespective of the situation of the tumor, without preliminary colostomy and without removal of coccyx or sacrum. A number of operators in this country follow the Miles technic and reduce the danger of shock by blood transfusion. One must remember that whether you use Miles technic or Coffey's or any other modification, there must be a colostomy, and the ultimate comfort of the patient rests upon the colostomy.

When I am able to remove the rectosigmoid cancer from above, I leave the lower bowel alone. When I must do a combined resection for a high cancer of the rectum I leave the anus and uninvolved rectum alone. At present I am against the combined abdominal sacral operation in one sitting and prefer the Coffey. I still think it is safer if the cancer of the lower rectum can be removed successfully from below in one sitting, even if the peritoneal cavity must be opened, to adopt this method. The patient can have an abdominal colostomy if the lower one is not suitable.

*Colostomy*—At present I would recommend first appendicostomy, which is kept open as a permanent functioning opening into the cæcum, second, when the colostomy is made to close the end of the colon, invert it, suture it into the abdominal wound laterally, and if there is a working appendicostomy do not open it until you are forced to, until the wound is healed. Then make a small opening. The patient can control everything except gas now and then. All patients wash the colon through the appendicostomy. One of my patients irrigates only twice a week and is perhaps the most comfortable of all.

*Conservative Operations for Cancer of the Lower Rectum and in the Region of the Anus*—I will mention two cases, one of which will be illustrated (Figs 4, 5, 6, and 7). The first was referred to me by my colleague,

Dr. William S. Thayer. The symptom of blood in the stools had been present but a few weeks. The proctoscope revealed a small polypoid tumor on the side toward the coccyx. The operation consisted of the removal of the coccyx, the opening and inspection of the upper rectum, the removal with a sufficient margin of the visible palpable tumor about the size of the end of the thumb, the complete suture of the rent in the rectum, and the partial closure of the external wound. This patient, of course, had complete control. The microscopical study shows a beginning cancer in the base of a polypoid tumor. In the future there will be more and more of such cases. Many will be found in periodic examinations if the proctoscope is used. In the second case, the mass was the size of the end of the thumb. It was situated in the anus, over the sphincter. It was a recurrent tumor, after an incomplete removal of a polypoid tumor microscopically malignant, and the growth was not checked by post-operative irradiation with X-ray. Under rectal anaesthesia, we removed with the cautery a piece of the recurrent tumor, demonstrated microscopical malignancy. Then, with the cautery, we removed the tumor with a good margin, just as we remove a lesion of the lower lip, a v-shaped mass of mucous membrane and skin with a portion of the sphincter muscle. The margins were then submitted to frozen sections, and as we had microscopical evidence that the recurrent local disease had been excised with sufficient margin, the wound was closed, catching the divided sphincter muscle in the suture. The remarkable result in this case is the good function. Unless he has a diarrhoea from indiscretions in diet he has perfect control, providing he empties his colon and rectum with enema in the morning.

Before writing these pages I had before me every history of cancer of the colon and rectum recorded in the Surgical Pathological Laboratory of the Johns Hopkins Hospital since 1889. I read in detail the histories of most of my personal cases. In these records there is a detailed description of every operation. I glanced over many of the early histories. Doctor Raiford went over with me his tables and we discussed his conclusions, mortality figures, and final results. So these pages are not written from memory only, but every definite statement is carefully checked from the original data. It was the first time that I had ever read Kraske's article, written in 1885. I learned the Kraske operation from Halsted and got my chief points on the resection of the right colon from William J. Mayo.

I hope the following somewhat new presentation of selected cases with illustrations will be helpful to those operators whose experience at this time is limited.

*Preliminary Pre-operative Irradiation*—When the cancer involves the anus and its removal means a complete resection, even a complete Kraske, and the patient is old and a bad operative risk, no harm is done by at least trying pre-operative irradiation, especially if large amounts of radium are available and a very experienced and competent radiotherapist. At the present writing my experience is too small to justify more than this statement.

# CANCER OF COLON AND RECTUM

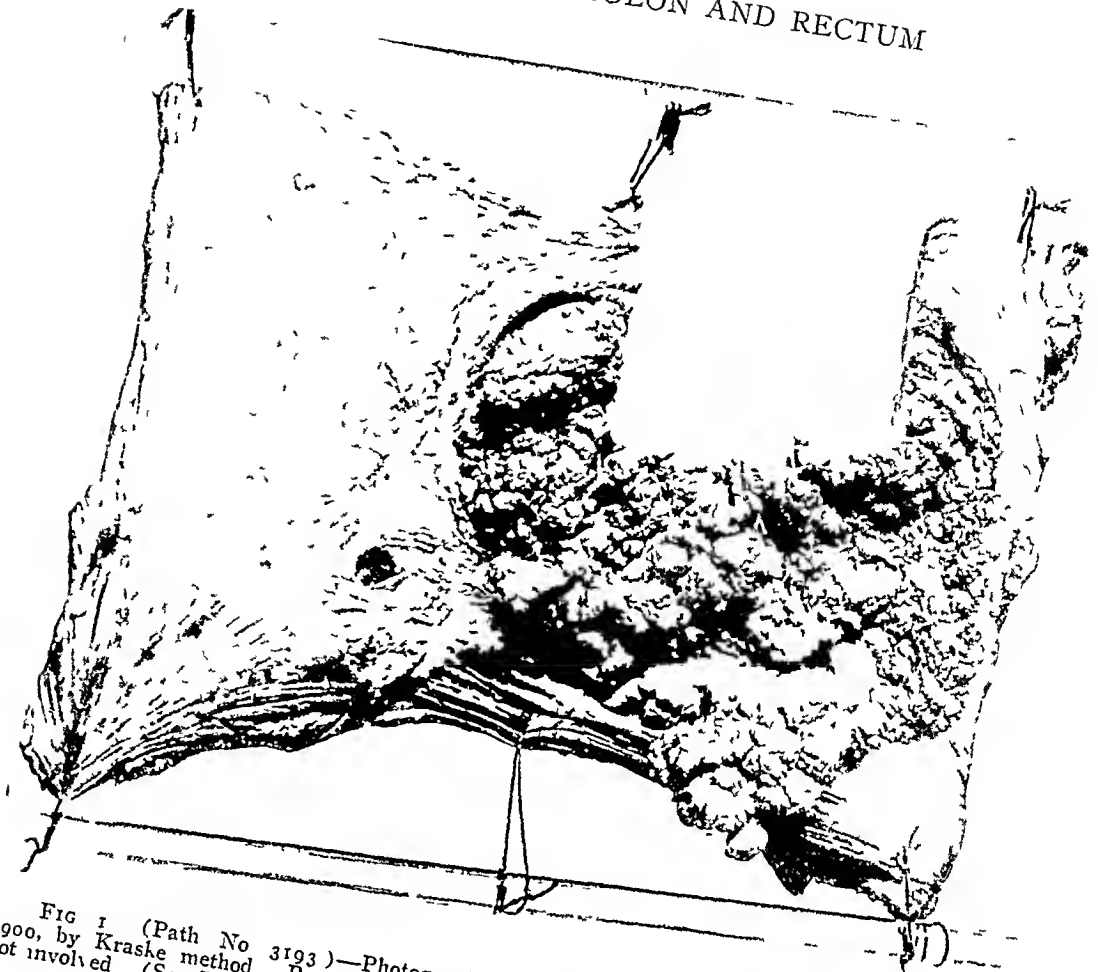


FIG 1 (Path No 3193 )—Photograph of resection of the lower rectum with anus in 1900, by Kraske method. Peritoneal cavity not opened. Lived twenty nine years. Glands not involved (See Figs 2 and 3 for microscopical pathology )



FIG 2

FIG 3

FIG 2 (Path No 3193 )—Low power ulcer shown in Fig 1. This has been diagnosed adenocarcinoma. Cells of a glandular type. Suggestive of low malignancy. Patient lived twenty nine years. FIG 3—High power of tumor shown in Fig 1. Adenomatous arrangement preserved. Cells glandular type but of the morphology of the malignant cancer cell. Metastasis is frequently observed in adenocarcinoma of the rectum and colon of this type. Practically all the cured cases are of the adenocarcinomatous arrangement, with cancer cells of this low grade glandular type.

CASES OF CANCER OF THE RECTUM—Figs 1, 2 and 3 (Path No 3193) Date of operation, July, 1900 Patient died, 1929, aged ninety years, twenty-nine years after operation, without any signs of local recurrence or metastasis Fig 1 is a photograph of the specimen removed after complete resection of the lower rectum following the technic of Kraske The rectum has been split and shows the surface of the superficial ulcer

Fig 2 is a low-power and Fig 3 a high-power photomicrograph, illustrating a low-grade adeno-carcinoma The patient was a white female aged sixty-one years She was a very intelligent woman, the wife of a clergyman, had observed some pain and bleeding for eight months after stool, consulted her physician, the late Doctor Scott, of Hagerstown, ten days before her admission to the hospital Doctor Scott immediately made a rectal examination, felt and diagnosed the local condition, and made arrangements at once for her admission to the Johns Hopkins Hospital

My note at that time in the hospital is as follows "Per rectum the finger feels a superficial fungus growth to the right and anterior, beginning five millimetres within the anus The finger could not get above the growth, but when the patient was under anæsthesia and the sphincter dilated we introduced Halsted's rectal speculum and could see normal mucous membrane above the growth

At that time, 1900, Halsted and his associates had had considerable experience with the resection of the rectum after the method of Kraske We had all learned from assisting Halsted how to do it The patient was placed on the back and the pelvis elevated on a specially constructed block with leg pegs—a position now used for perineal prostatectomy, a position then used for the Whitehead operation for hemorrhoids Halsted's speculum was introduced, the rectum inspected and cleansed, packed with gauze to which silk ligatures were attached The anus was not sutured A straight incision was made from anus to the middle of the sacrum The coccyx and lower fourth of the sacrum were removed Largely by blunt dissection, everything was cleaned out in the space between the rectum and sacrum Then the anus and a zone of skin were encircled with a skin incision, the skin flap dissected back, and the entire rectum isolated as one mass with all its surrounding tissue to a position well above the growth, as shown in Fig 1 When the patient was a male a sound was introduced into the bladder to protect the urethra Rarely did we have any difficulty with the prostate In a few instances, the prostate was partially removed, in one completely removed Now and then one or both seminal vesicles were removed None of these patients was permanently cured As in the case shown in Fig 1, the low position of the growth allowed its removal without entering the peritoneal cavity In many instances, the peritoneal cavity is opened in order, not only to give the growth some margin, but to mobilize the sigmoid downward in order to make a proper sacral anus In recent years when the new growth is situated high we prefer to make first a permanent sigmoid colostomy and appendicostomy and then resect the tumor and rectum from below with or without opening the peritoneal cavity and leave the upper portion of the colon In some instances the lower rectum and anus, if not involved, remains undisturbed I have just heard from a patient [and his physician] upon whom this method was employed This method, when it can be done, is less dangerous than the plan of Coffey or the complete resection chiefly advocated by Miles, of London When properly selected, one runs no more risk of local recurrence and just as large probabilities of a permanent cure I am confident the mortality would be less than the more complete operations except in the hands of the most expert and experienced operators

The wound left by the Kraske resection, whether combined with the abdominal route or not, takes time in healing The convalescence is uncomfortable, even when there is an abdominal colostomy There appears to be no other way of properly removing cancer of the rectum or rectosigmoid

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colon The removal of a piece of sacrum should be avoided if possible in order to relieve the patient of post-operative temporary catheterization of the bladder, not necessarily dangerous, but unpleasant

Doctor Raiford confirms my observation up to date in the fact that there has been but one case with microscopically involved glands in the pelvis that has been permanently cured more than five years In this case it is more than fifteen years since the operation

From my experience the principles of the Kraske operation should remain unchanged today when indicated by the extent or position of the growth They are as fundamental and fixed as Billroth's resection of the stomach and Halsted's complete operation for cancer of the breast

Figs 4, 5, 6, and 7 (Path No 41,354), illustrate the gross and microscopical picture of a polypoid tumor removed through the sacral route from the middle third of the rectum The wound was closed, healed, and the patient had perfect function and is well three years since operation The patient was referred by Doctors Thayer, of Baltimore, and Sloan, of Parkersburg, West Virginia, in February, 1929 The patient was a white female, aged forty-two years A polypoid tumor the size of the end of the thumb (twenty-five-cent piece) could be felt with the index finger ten centimetres above the anus and clearly inspected with the proctoscope It was sessile and not pedunculated All examinations and laboratory studies were negative The patient, though married, had no children The probabilities are, had she had children and been subjected to the new rule to examine the rectum with the proctoscope when a pelvic examination is made, here would probably have been revealed the polypoid tumor when it was small and it could have safely been removed through the rectum with a snare Seven years ago, when she was operated on for hemorrhoids, no proctoscopic examination was made The patient had observed bleeding from the rectum for a year During this year she saw a number of physicians because of her bleeding and gas pains, but received treatment without examination Doctor Sloan, when consulted, demonstrated the presence of this polypoid growth at once, and referred the patient to Doctor Thayer

*Operation on the Tumor Shown in Figs 4 and 5*—On account of its high position, we followed the basic principles of Kraske and removed the coccyx and a small piece of sacrum This allowed us to open the rectum above the tumor First, however, we removed tissue between the rectum and coccyx, made frozen sections, and found no lymphoid tissue and no cancer The rectum was then opened by a longitudinal incision and we could see and feel the tumor, as shown in Fig 4 There was no infiltration in the wall of the gut around its base It was the size of a silver dollar, that is, larger than it felt per rectum with the finger or appeared in the proctoscope The base of the tumor was one-half the diameter of its surface The gross section of the tumor is shown in Fig 5 There is no naked-eye evidence of any infiltration into the tissue removed beneath the base of the pedicle This tissue consisted of the thin submucous wall of the gut and fat and fibrous tissue beyond The immediate frozen sections were even clearer than the photomicrographs of the permanent sections shown in Figs 6 and 7 Shall we call this a benign polypoid growth or carcinoma? Compare Figs 6 and 7 with Figs 2 and 3 They appear identical The tumor in the gross from which the sections in Figs 2 and 3 were taken was malignant The gross appearance of this polypoid tumor of Fig 5 suggests malignancy From my studies of the benign type of adeno-carcinoma of the colon and rectum I am inclined to view all polypoid tumors as malignant or potentially malignant The polypoid tumor with a sessile base should be removed by resection or at least the complete wall of the gut beneath and around the base

We have two cases of lesions diagnosed polypoid tumor in the rectosigmoid colon Both were removed from below through the proctoscope by a snare Both recurred

And later I removed them by resection of the sigmoid colon through the abdominal route with end-to-end suture. The recurrent tumors were microscopically malignant.



FIG 4



FIG 5

FIG 4. (Path No 41,354)—Polypoid tumor mid third of rectum removed with zone of normal mucous membrane through sacral wound. Photograph of surface showing the raised, somewhat fungated cauliflower sessile polypoid mass, stained with hemorrhage. (See Fig 5 for section)

FIG 5. (Path No 41,354)—Cross section of tumor shown in Fig 4. The surface suggests a cancer rather than benign polypoid tumor. It is circumscribed at the base and removed with a margin of an uninvolved gut and fat.

The patients, however, still remained well three and five years after the operation. When you grasp a polypoid tumor and lift it and demonstrate that it has a pedicle of normal



FIG 6



FIG 7

FIG 6—Low power photomicrograph of tumor in Fig 5. Is this a benign in a polypoid growth or an adenocarcinoma? Compare with Fig 2.

FIG 7—High power photomicrograph of tumor shown in Fig 5. Compare with Fig 3 a typical gross cancer of the rectum.

mucous membrane, you can remove it locally, which I have done recently on a few occasions.

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*Closure of Wound in Case Shown in Figs 4 and 5*—The opening into the rectum was closed with interrupted oo chromicized catgut with here and there a continuous suture. The second layer was continuous catgut reinforced with fine silk. The external wound in the skin was partially closed above and below. The wound healed without leakage of gas or fecal matter, and within two weeks the external wound was healed. It is now almost three years since the operation. There is perfect function and no return of symptoms.

*Cancer of Rectosigmoid Colon*—Removed by combined abdominal and sacral route with restoration to normal by end-to-end suture in the sacral wound.

Fig 8 (Path No 6550) This illustration taken from a sketch is republished from Fig 3, Surgery, Gynecology, and Obstetrics, August, 1906. The lower third of the sigmoid and the upper third of the rectum have been removed with the cancerous tumor by the combined route. The upper sigmoid has been mobilized and drawn into the sacral wound. The peritoneum has been sutured to the sigmoid, closing off the peritoneal cavity. The mobilized sigmoid has been sutured to the lower third of the rectum in the sacral wound. There is a temporary lateral colostomy above. This operation was performed by me at Johns Hopkins Hospital in 1905. A small fistula developed at the site of the end-to-end suture in the sacral wound. There was ultimate healing with a small sinus. This gave the patient some trouble from time to time. I have alluded to this case in the text. Eight years later, in 1913, the right colon was resected for a second carcinoma, and the patient died a few months later of nephritis. This diagram in Fig 8 illustrates the different possible types of the combined operation. In the most radical, the entire rectum and colon are removed and the lower end of the upper sigmoid remains as a permanent colostomy in the abdominal wall. In the Coffey the same colostomy remains. The first operation is entirely abdominal. A portion of the sigmoid colon, closed and inverted above the cancer of the lower sigmoid and upper rectum, is pushed beneath the rent in the pelvic peritoneum and then the rent is sutured. This places the malignant disease with the surrounding and lower gut extraperitoneal, to be removed later through the sacral wound. Coffey writes me he still drains by an incision in the sacral area to this subperitoneal space in which the inverted end of the depressed gut is situated. I have never used the drainage, which seems unnecessary if you properly close, invaginate and suture the colon above the tumor. The majority of operators following the Coffey technic at the second operation through a sacral wound remove the entire gut, including the anus. In recent years I have restricted the resection to the upper portion, leaving the anus and lower third of the rectum. It seems to be a simpler procedure and leaves a smaller wound to heal by granulation. We must remember, however, the possibilities of secondary polypoid growths in the gut left behind. If it is possible to divide the gut below the growth through the abdomen, with or without dividing the peritoneum around the gut in the depth of the pelvis, then one lifts the tumor and upper gut out of the peritoneal cavity and performs a permanent colostomy of the end of the colon left behind. The lower gut is closed and invaginated and placed extraperitoneally just as in the Coffey operation, but the lower rectum is left intact, as the tumor has been removed through the abdominal wound. These are the various possible combinations. Doctor Raiford is attempting from a study of our own cases and the literature to estimate the mortality of the different methods, but there are many factors in operative mortality that have more to do with the condition and vital resistance of the individual patient than with the technic of the operation and skill of the operator. There is no question that we should choose the operation of least risk in the resection of cancer of the rectosigmoid colon. In the first place, there is a choice. A more extensive removal above and below the tumor area with a more extensive removal of the mesenteric area or tissue in the sigmoid extraperitoneal space is unnecessary to give the patient a better chance of a permanent cure. The operable malignant area of the colon does not require a wide margin of uninvolved gut, and as metastasis to glands practically makes the case



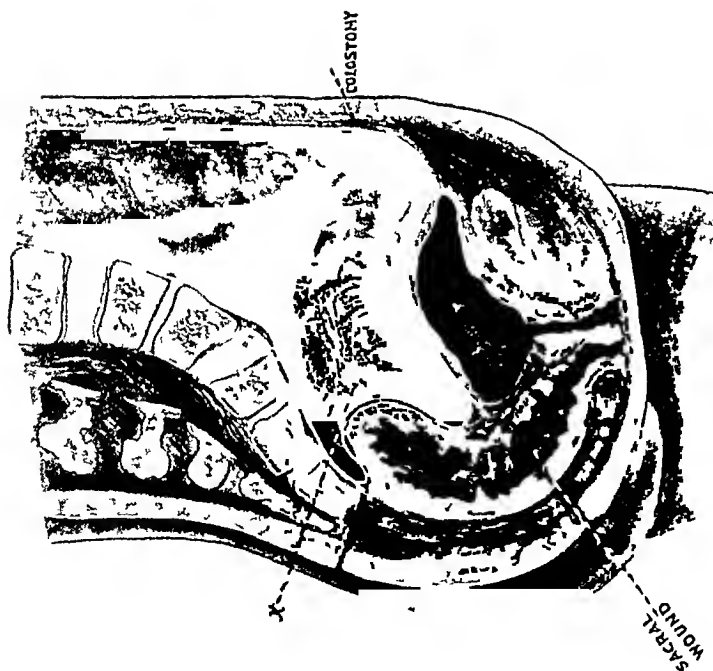


Fig 8

FIG 8 (Path No 6550 )—From Fig. 3, Case 1, Surgery, Gynecology and Obstetrics August, 1906 Diagram illustrating relation of parts after the complete combined operation for cancer in the rectosigmoid colon and end to-end suture of colon to lower rectum in the sacral wound X—suture of peritoneum around colon in floor of pelvis Opposite sacral wound end to end suture Opposite colostomy, lateral temporary abdominal colostomy

Fig 9 (Path No 2433)—X-ray after bismuth per rectum. Three years after operation of a case similar to that shown in Fig 8. The operation in the case shown in Fig 9 was practically identical to that illustrated in Fig 8. In both there was a slight leakage at the site of the suture. In both the temporary colostomy closed spontaneously and function was restored. The patient illustrated in Fig 9 is living today almost twelve years after operation. He was able to continue his duties as a railroad engineer and sent me a photograph of himself and his engine five years after his operation.



Fig 9

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hopeless, it is unnecessary to risk post-operative death in order to remove more of the glandular area. My recent experience teaches me to perform under local anæsthesia appendicostomy first except where the cancer is in the anus and in the low rectum so situated that it can be completely removed by a low resection. If the patient does not prefer the sacral anus a permanent colostomy can be performed later. When there is an appendicostomy the next stage is a laparotomy. If the tumor cannot be completely removed from above I prefer the Coffey operation in two stages. In thin people it is less difficult to operate from above alone. In more deeply situated tumors the peritoneum can be divided and the tumor isolated below, the gut divided between clamps with the cautery, the lower gut closed, even without a peritoneal surface, with three rows of fine black silk. A rectal tube can be passed per rectum, as Coffey does, to aid in more thorough invagination. Then the peritoneum can be closed over this lower portion. There is no doubt that the difficult part of the operation is in the lower pelvis of the abdominal cavity, but the operation with the greatest element of shock is the sacral operation. If possible, the abdominal and sacral, if they must be done, should be done in stages. Appendicostomy with proper pre-operative preparation and blood transfusion is reducing mortality from shock. The danger of end-to-end suture deep in the pelvis, with or without a tube, or by Halsted's buttress suture, is so difficult even in the hands of the experienced operator and the danger of peritonitis from faulty circulation of the ends of the gut so great that I prefer a permanent colostomy to this attempt, although I have had a number of successful cases.

Fig 9 (Path No 24,433) An X-ray after bismuth per rectum, three years after an operation similar to that shown in Fig 8. The operation in the case shown in Fig 9 was practically identical to that illustrated in Fig 8. In both there was a slight leakage at the site of the suture. In both the temporary colostomy closed spontaneously and function was restored. The patient illustrated in Fig 9 is living today, almost twelve years after operation. He was able to continue his duties as a railroad engineer and sent me a photograph of himself and his engine five years after his operation.

This paper cannot be lengthened any more by discussion of the details of the various methods of preparation for and operative attacks on cancer of the colon situated too deep in the pelvis for safe resection and suture, or so situated that resection and suture are impossible or must be done in the sacral wound. I have read over a series of operative notes dictated by me during or directly after the operation and at this time I feel it inappropriate to put them into the literature. Perhaps it would be helpful to my own associates and interne staff in the hospital to read them over after assisting at such an operation, but they are appropriate only for a very large monograph or book. I hope ultimately they will be as helpful as Kraske's description of his technic in 1885 and the Mayo Brothers' contributions to the surgical technic of resection of the colon from cæcum to anus.

*Resection by Coffey's Method*—Figs 10, 11, and 12 (Path No 35,822) Pictures of the gross and microscopical pathology of a tumor situated in the upper rectum which was removed by a modified Coffey operation in 1924. The patient is well today, almost eight years since operation. The microscopic pathology in Figs 11 and 12 should be compared to Figs 2, 3, 6, and 7. This case still retains the picture of an adenocarcinoma. The cells, however, appear more malignant. The glands were not involved. At the time of this operation in October, 1924, I found that I could feel the mass per rectum. You will observe in Fig 10 the anus to the right and the tumor to the left. It seems so small and so accessible from below with apparently sufficient margin of rectum below it that I planned to resect it and restore the continuity of the bowel by suture in

the sacral wound. The patient was very averse to an abdominal colostomy, and up to that time I had not succeeded in giving perfect control. I performed appendicostomy first,



FIG 10. (Path No 35,822)—Photograph of the resected lower half of the rectum through the sacral wound in the second stage of the Coffey operation. In spite of the small operable ulcer which could be easily felt with the index finger in the rectum there had been pain and bleeding for a year. No recurrence to date, almost eight years. (See Figs 11 and 12 for microscopical picture.)

because the patient was not a good risk and I felt in this way I could give him better pre-operative preparation. I then explored and could not palpate the tumor above. As

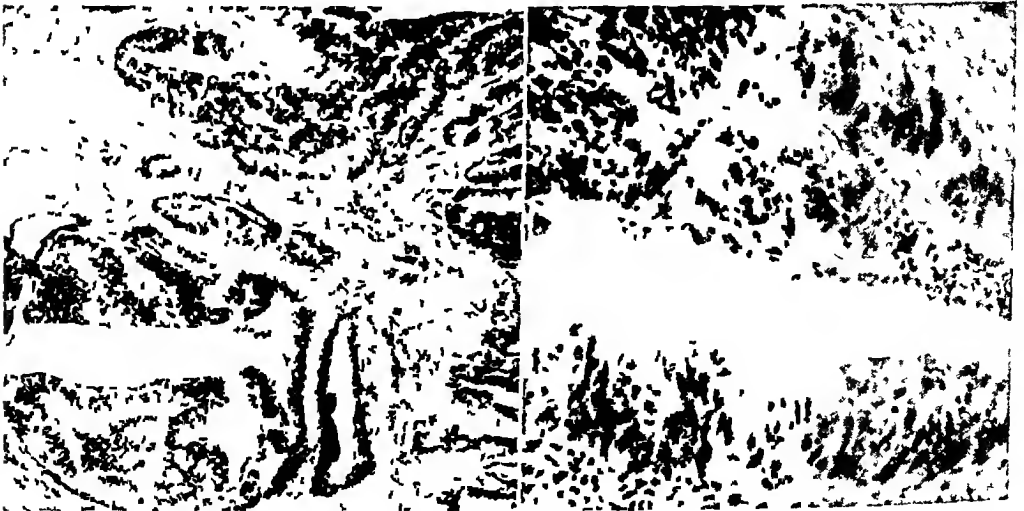


FIG 11

FIG 12

FIG 11 (Path No 35,822)—Low power ulcer rectum, shown in Fig 10, diagnosed adenocarcinoma. Glands not involved. Well no recurrence, almost eight years.  
FIG 12 (Path No 35,822)—Section shown in Fig 11. Morphologically, glandular cells are malignant and suggest a higher grade of malignancy than those in Figs 7 or 3.

the patient was not in good shape I changed my mind to the first stage of the Coffey operation. In making the permanent colostomy I closed and invaginated the end of the

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colon and sutured it laterally in the upper portion of the abdominal wound. It had to be done hurriedly as the patient was showing signs of shock. On account of his condition I was not able to make as painstaking an invagination and suture of the gut above the growth in the lower pelvis. However, I made a thorough suture of the rent in the peritoneum and sutured the bladder over it as a further safeguard. Ten days after operation, on account of fever and leucocytosis, I removed a portion of the coccyx and sacrum and extirpated the tumor and the rectum through the sacral wound. There was an accumulation of blood-stained fluid in the cavity about the sutured end of the gut and cultures grew colon bacilli. This demonstrates the value of Coffey's drainage when your



FIG 13



FIG 14

FIG 13 (Path No 38,406) —This X ray pictures a typical hour glass filling defect in the lower sigmoid. In this case the tumor was situated sufficiently high to allow resection and end to end suture in the pelvis through the " " For specimen removed see Fig 14

FIG 14 (Path No " " of specimen shown in X ray (Fig 13) The narrow margin of gut below the tumor was due to a low position of the palpable mass in the pelvis. Nevertheless, it is sufficient margin for the malignant area. The longer portion of the gut above is explained by the redundant sigmoid. The end to end suture was successful. The morphology of the cancer cell in the tumor in this case was very malignant, and in spite of the operability of the local growth the patient died of metastasis within four months.

technic is faulty. The patient had a long and tedious convalescence, because of the slow healing of the wound. However, he has been compensated with a perfect function of the appendicostomy and sigmoid colostomy. The appendicostomy admits the smallest catheter, the colostomy just admits the little finger. He has tried various methods of irrigation. The one that works best is an irrigation every two or three days with a catheter through the appendicostomy. He wears nothing but some gauze and an ordinary abdominal binder. There is no leakage of fecal matter. Now and then a little gas escapes, especially when he is playing cards at night. "Then," he says, "he blames

it on the other fellow " This case has demonstrated to me the great value of preliminary and permanent appendicostomy, and the proper method of making a colostomy which will not prolapse and not leak except now and then gas Function here is far better than that usually obtained by a sacral colostomy, although the function in the case illustrated in the case Fig 1 was ultimately as perfect

Every attempt should be made to give these patients the best functioning colostomy This can always be done at a secondary operation when the first resection is safer with a sacral anus

*Cancer Resection Sigmoid—End-to-End Suture in Pelvis—Figs 13 and 14*



FIG 15 (Path No 3887)—X ray of a cancer of the rectosigmoid with symptoms of three years' duration, and after X ray treatment over a period of more than two years (See text for details)

(Path No 38,406) Fig 13 demonstrates how clearly some tumors of the colon give an hour-glass filling defect which allows an almost positive diagnosis of at least a lesion that should be subjected to exploratory operation The photograph of the specimen removed is shown in Fig 14 We were able to resect this palpable mass from above by giving it the narrow margin below shown in the photograph and perform a successful end-to-end anastomosis That more gut was removed above the tumor was due to a very redundant sigmoid Removal of this extra-long piece simplified end-to-end anastomosis and left ends of gut with better circulation A temporary lateral colostomy was made

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above the suture. No glands could be seen or felt. The patient returned after four months of comfort with signs of partial intestinal obstruction and much fluid in the peritoneal cavity. An exploratory laparotomy revealed fluid, glandular metastasis everywhere, but no obstruction at the point of anastomosis, but higher up in the small intestine, due to mesenteric-gland involvement.

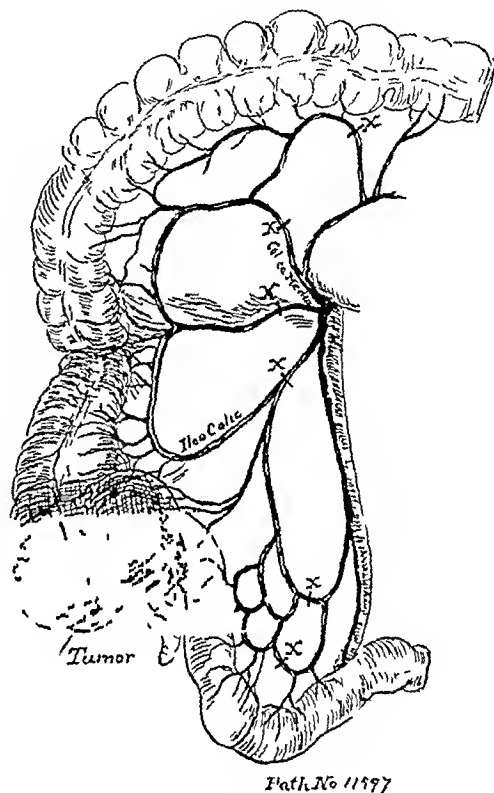
The result in this case can first be explained by delay. This patient had definite symptoms for three and a half years, sufficient to justify a proctoscopic examination and the X-ray study after bismuth per rectum. Finally, obstructive symptoms of such a degree brought him under the observation of a physician who made an immediate complete examination and found the cause and site of the trouble. Second, the microscopical sections of the tumor shown in Fig 14 show a high-grade, fully developed carcinoma, in great contrast to the microscopical pictures that we have reproduced in this article. Unfortunately, the photomicrograph of this case has been mislaid, and cannot be reproduced. You will observe in Fig 14 the type of a cancer of the large gut that produces a small tumor area but marked annular constriction. This is not always associated with long symptoms or a morphologically more malignant type of cancer cell. We cannot explain why some tumors remain an ulcer without obstruction and may be very extensive and yet superficial and why other local growths constrict and others perforate, producing a general carcinomatosis of the abdominal cavity.

Fig 13 (Path No 30,406) This X-ray pictures a typical hour-glass filling defect in the lower sigmoid. In this case the tumor was situated sufficiently high to allow resection and end-to-end suture in the pelvis through the abdominal wound. For specimen removed, see Fig 14.

Fig 14 (Path No 38,406) Photograph of specimen shown in X-ray (Fig 13). The narrow margin of gut below the tumor was due to a low position of the palpable mass in the pelvis. Nevertheless, it is sufficient margin for the malignant area. The longer portion of the gut above is explained by the redundant sigmoid. The end-to-end suture was successful. The morphology of the cancer-cell in the tumor in this case was very malignant, and in spite of the operability of the local growth the patient died of metastasis within four months.

*Cancer or Sigmoiditis*—Fig 15 (Path No 38,872) This X-ray showing the involvement of the rectosigmoid colon, which had not produced obstruction, was taken three years after symptoms and one year and six months before death from metastasis.

This patient came under my observation with a diagnosis of cancer of the upper third of the rectum, based upon a proctoscopic examination and X-ray. He had been given repeated deep X-ray treatment. He was fairly comfortable. When I explored the area I found it inoperable, because the bowel was adherent everywhere to the pelvis and lower lumbar vertebra. As the patient was comfortable and there was no obstruction, I decided to do an appendicostomy only, and again I could not tell whether the mass was cancer or sigmoiditis. If the mass was cancer, which it later proved to be, the X-ray had apparently produced a definite inflammatory exudate which we rarely ever see in cancer not treated in this region. This patient lived and worked in comfort for a year.



*Abd. Tumor of Cecum*

FIG 16 (Path No 11,597)—Diagram of anatomy of first portion of ileum and right colon, to illustrate operation, resection of right colon, 1911

and a half and then, on account of obstruction, was given the benefit of a sigmoid colostomy without investigation of the pelvic growth. The patient lived about a month after this operation. I have no way of determining the value of the X-ray treatment in this case. He was given deep X-ray without exploration and it was associated with a number of years of comfort. I also have no way of determining whether my appendicostomy put off the later colostomy. The X-ray treatment stopped the bleeding. I am inclined to the opinion that this patient should have been explored when his first bleeding took place, in 1924, more than four years before his death.

*Cancer of Cæcum and Colon*—Fig 16 (Path No 11,597) This diagram was made in May, 1911, almost twenty-one years ago. It is a copy from an anatomy. I have already discussed it. It is to illustrate the point of the necessity of the operator to appreciate the circulation of the large gut as directing him where he shall make his resection, no matter what type of suture may follow. The circulation of the small intestine has much more collaterals and the danger of necrosis at the point of division is very slight as compared with the large intestine.

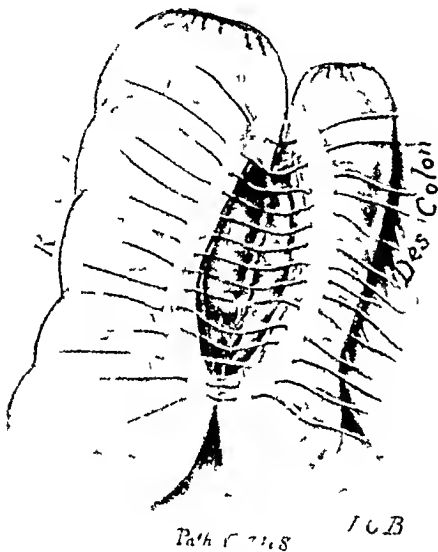


FIG 17A

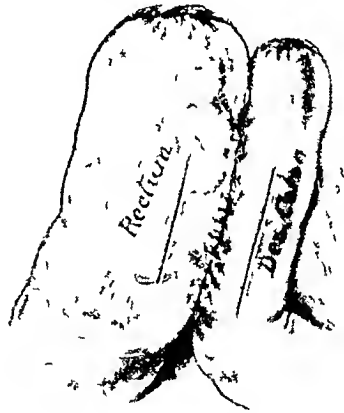


FIG 18B

FIGS 17 and 18—From Fig 6 A and B *ANNALS OF SURGERY*, volume LXV, February, 1909  
B—first stage A—Second stage Lateral anastomosis. Closed inverted ends of gut pointing in the same direction to allow extraperitoneal suture. (See Fig 19)

*Intestinal Suture*—Figs 17, 18 and 19 are taken from Fig 6, A and B, and Fig 7 from the *ANNALS OF SURGERY*, vol LXV, p 168, February, 1909. Fig 17 (old No Fig 6B) shows the method of suture in which three rows of fine black silk are employed. In this figure the first row of sutures has been applied and the division of the gut on each side has been made through to the mucous membrane. The suture is the same way whether it is end-to-end, end-lateral, or lateral. In Fig 18, all the posterior sutures have been applied, tied and cut. The artist in this case has not applied the first row of sutures properly. They should pass through the mucous membrane and be tied on the mucous-membrane side. He has drawn in only the second row. This method of suture was the original method of Billroth and is pictured in all his illustrations. I adopted it and have followed it with few exceptions throughout. The majority of surgeons today use catgut, especially for the mucous-membrane suture and the continuous suture. Many use catgut throughout. The object of this suture, as shown in Figs 17 and 18, is to allow the two inverted ends of the gut to be placed extraperitoneally, as shown in Fig 19 (Fig 7 in *ANNALS OF SURGERY*). Then, if there is any leakage, it will be extraperitoneal.

## CANCER OF COLON AND RECTUM

I am going over carefully all the illustrations of tumors from cæcum to sigmoid. In gross pathology they showed the same characteristics of the few that we have already illustrated, and I shall leave their publication for Doctor Raiford's monograph. Only one will be selected to illustrate the point that some apparently inoperable tumors, even those that have had previous incomplete operations, may not only be operable but curable. *Apparently Inoperable Cancer of Colon*—Fig 20 (Path No 28,918). This mass, which consists of loops of adherent small intestines, a large bit of the abdominal wall, including the skin encircling the former scar, and the cæcum with the new growth, was excised at St Agnes Hospital, in 1921. The patient was then given post-operative X-ray by my colleague Doctor Kahn. This patient is well today, 1932. In April, 1921,

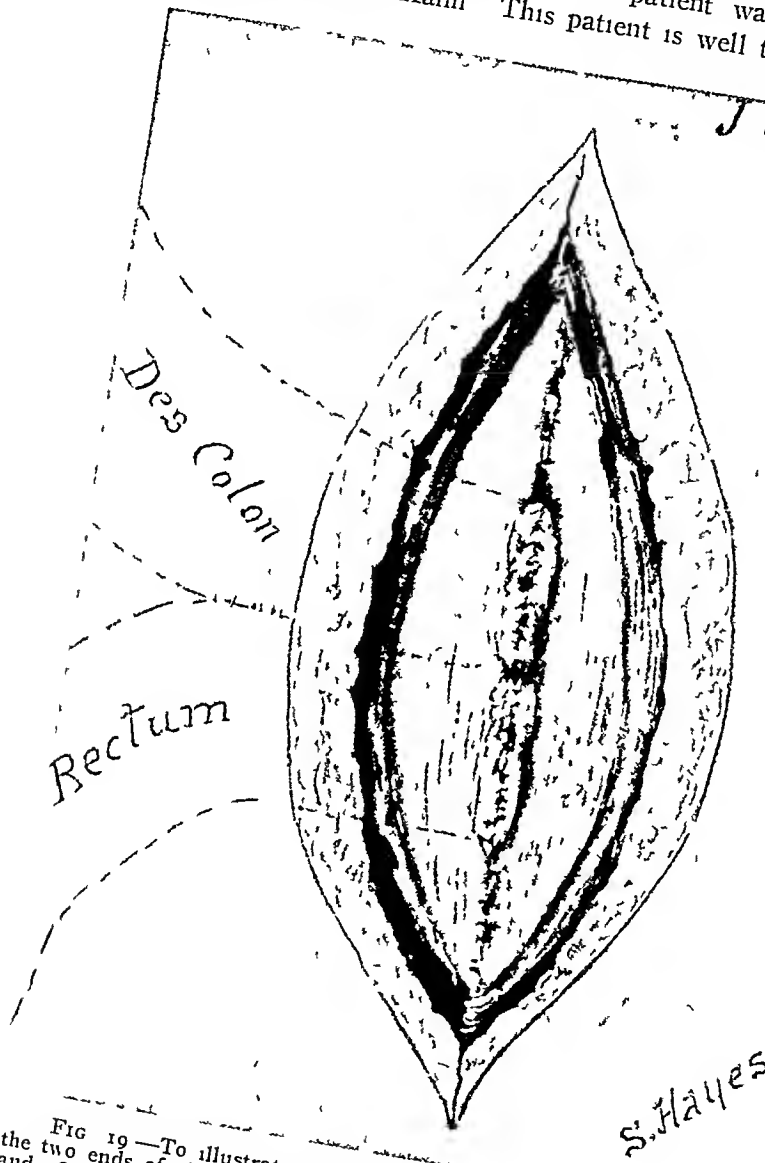


FIG 19—To illustrate the extraperitoneal position and suture of the two ends of the gut in the lateral anastomosis shown in Figs 17 and 18 in the abdominal wound

in this case the abdomen was opened on the diagnosis of appendicitis. The operator found what he thought to be an inoperable cancer of the cæcum. He removed a piece of the wall of the cæcum for diagnosis. It proved to be microscopically adeno-carcinoma, of a moderately low-grade malignancy. The operation of complete resection by me at St Agnes took place five months after the exploratory operation. On admission to St Agnes Hospital, he had a small fecal fistula, a palpable mass with induration of the abdominal wall. When we opened the peritoneal cavity, there was no difficulty in picking out a piece



of ileum above the adherent loop, dividing it, closing the two ends, and then isolating the mesenteric vessels, until we reached the mesentery of the cæcum. Then we ligated these vessels in the mesentery until we explored the ascending colon and ligated it. When this was complete all we had to do was to remove the fistula, the scar, with a zone of skin, a wider zone of muscle and fascia. The adhesions on the outer side of cæcum and colon gave no difficulty. The complete separation of the mass and its removal required but an hour. A lateral anastomosis of the ileum and ascending colon was performed in the usual way. As we expected to bury the suture in order to fill the rent in the posterior peritoneum we covered the closed end of the colon by suturing the ileum and its mesentery to it. There was a considerable wound in the abdominal wall, but there was no difficulty



FIG 20 (Path No 28,918)—Photograph of loops of small intestine adherent to a cancer of the cæcum with the adherent wall of the abdomen completely resected in 1921. Well in 1932

in closing off the peritoneal cavity. Much of the remainder of the wound was left open and drained. The tumor proved to be an extensive carcinoma of the cæcum and cancer tissue had grown into the abdominal wall itself and into the small intestine. But the glands showed no involvement. This patient has had no symptoms of recurrence or obstruction since the operation in 1921. Not infrequently has cancer of the cæcum assumed the clinical picture of chronic appendicitis. The palpable mass may be interpreted as adherent omentum about an infected appendix. In carefully studied cases the diagnosis of a condition other than appendicitis should be made. All operators must remember that in an exploratory operation on the diagnosis of chronic appendicitis when there is a palpable lump the possibility of a malignant operable tumor of the cæcum must be borne in mind.

#### SUMMARY AND CONCLUSIONS

Surgeons cannot with justice either to themselves or the public assume that their responsibility begins with the pre-operative preparation. The chief cause of failure to cure cancer of the colon and rectum is late intervention.

Contributory causes are incomplete pre-operative investigation in which the pre-cancerous or cancerous lesion is overlooked by some member of the medical profession and valuable time lost. The entire medical profession are apt to make the mistake of performing an incomplete diagnostic study before operation or an incomplete pre-operative preparation. Apparently the least factor in the failure to cure the majority of cases and cancer of the colon and rectum is the operative skill of the surgeon. This factor may be too large but it cannot be compared with the delay on the part of the patient and the failure to recognize an operable condition on the part of the general practitioner who does not keep up with modern diagnostic methods. Undoubtedly, in cancer of the rectosigmoid colon, surgeons of less experience and skill have too large a mortality. As I suggested in this paper, there should be no difficulty for them to recognize these cases clinically and back out gracefully either before any operation or after an exploratory laparotomy. In the latter event they can perform preliminary appendicostomy and save the patient much time.

I take the liberty of recommending appendicostomy preliminary to resection of every part of the colon except the right colon when the cæcum is removed. My impression is that lateral anastomosis, when possible, is safer than end-to-end. When the colon itself must be resected, the safest method of anastomosis, if it possibly can be done, is illustrated in Figs 17, 18, and 19. In tumors of the rectum and rectosigmoid pathological studies and final results demonstrate that it is unnecessary for a cure to give the malignant tumor of the colon or rectum such wide margins of gut. The restricted operation should be chosen when possible, if it promises lessening of the operative risk. For the same reason, operation in stages should be chosen and blood transfusion freely employed. Do not wait for symptoms of shock—anticipate the collapse. Also, it should be remembered that the rectal tumor can be properly removed through the sacral route. It is perfectly possible to perform an abdominal colostomy if the sacral one is unsatisfactory. Many of our most experienced and best-trained diagnosticians often curtail the pre-operative diagnosis the moment something definite is found indicating surgical intervention. Many experienced surgeons do not give the patient before operations upon the colon proper pre-operative preparation. If there is obstruction, colostomy is indicated, which can be part of a pre-operative diagnosis and preparation, because the obstruction must be relieved. I recommend appendicostomy without exploration to determine the position of the tumor unless there are definite symptoms indicating the necessity of further exploration.

# BRIEF COMMUNICATIONS

## SOME SUGGESTIONS IN EXPERIMENTAL SURGERY

### I TECHNIC FOR OPENING AND CLOSING THE THORAX

### II SIMPLE METHOD FOR THE TRANSPLANTATION OF THE URETER AND THE COMMON BILE-DUCT INTO THE INTESTINE

(I) *Technic for Opening and Closing the Thorax*—In many research investigations an important part of the operative procedure is a certain type of surgical manipulation within the cavity of the thorax. Although such procedures in experimental work have been common since Carrel\* reported his first successful experiments, a simple and satisfactory method which can be employed in most laboratories is apparently not available. For several years we have used a technic for thoracic surgery which has proved to be very successful. The essentials of the method are (1) an intercostal incision without resection of a rib, (2) wide traction with a strong, spreading retractor, and (3) strong sutures passing around each rib adjacent to the incision.

After the animal has been completely anesthetized, and intratracheal artificial respiration has been started, it is placed on its side to expose the part of the thorax to be opened, a wide area of this side of the thorax having been shaved, washed with a fat solvent, and painted with two coats of 2 per cent iodine in ether. The usual sterile linen is used for draping the animal, and the strictest asepsis is maintained at all times.

The interspace in which incision is to be made varies with the thoracic organs to be exposed. The first incision is made through the skin and subcutaneous tissue. The length of the incision varies with the size of the animal but should be large enough to permit good exposure. The edges of the skin are covered by towels, and the incision is carried on into the pleural cavity. A strong, self-retaining retractor is placed in position and the ribs are widely separated to permit easy access to the organs of the thorax. Any organ in the thorax can be approached with this exposure.

In closing the incision, interrupted sutures of heavy cobbler's thread are used for approximating the ribs, the sutures are placed about 2.5 centimetres apart, beginning well down in the angles of the wound. Each suture encircles the rib on each side of the wound. They are not tied until all are in place and the ribs have been drawn together with towel clips. The fascia and subcutaneous tissues are brought together with a running suture of No. 2 chromic catgut. When the first suture line has been completed, an artery forcep is inserted into the pleural cavity and opened. The air is then completely blown out of the thorax by increasing the intrapleural pressure, and the forcep is quickly withdrawn. The second suture line of catgut is

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\* Carrel, Alexis. On the Technic of Intrathoracic Operations. Surg., Gynec., and Obst., vol. xiv, pp. 226-228, July, 1914.

then completed. Linen is used for closing the skin. A single layer of gauze, covered with collodion, is the only dressing used. Stitches are not removed unless they become infected.

(II) *The Transplantation of the Ureter and the Common Bile-Duct into the Intestine*—Many methods have been devised for transplanting the ureter into the large intestine. Most of these we have tried experimentally. Although we have been successful, occasionally, in obtaining function of the kidney with each method, the percentage of satisfactory operations has not been high. Failures may be attributed to two main causes: the complexity of the technic, and the thickness of the muscularis of the large intestine of the dog. However, after various experiments, we finally adopted a simple

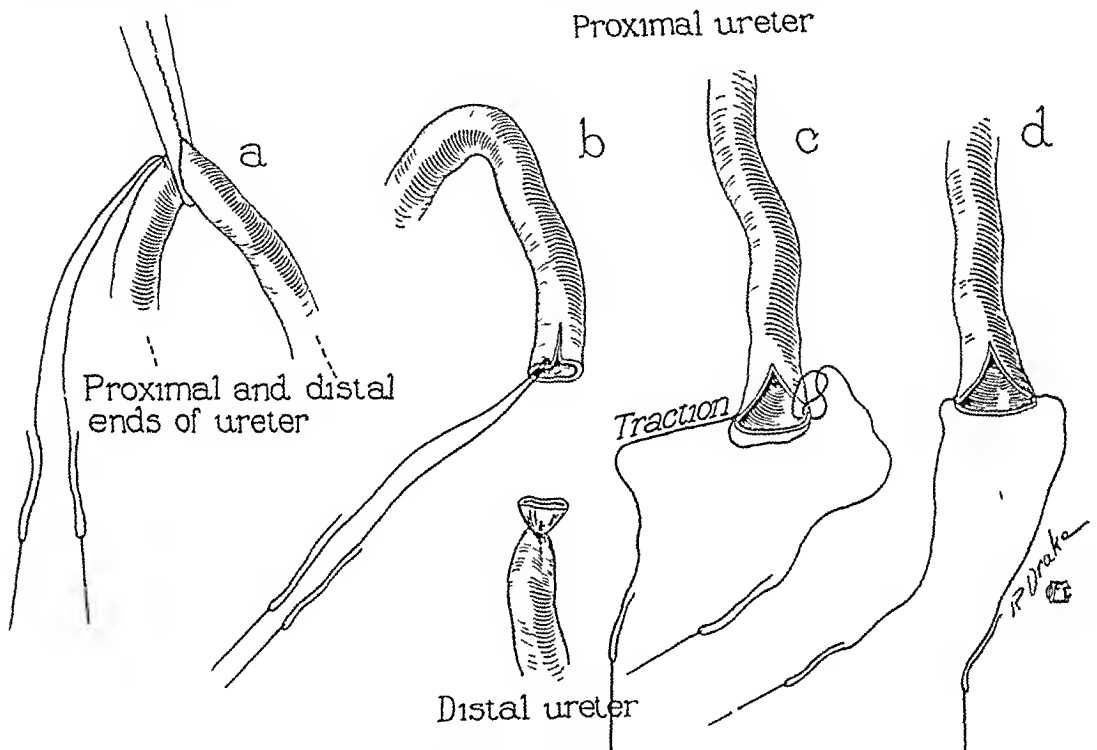


FIG. 1.—Method of preparing ureter for transplantation into bowel

and satisfactory technic. We are presenting it here since it may be of value to experimental workers who desire a simple method for transplanting the ureter or similar structures.

*Preparation of Ureter*—We shall describe the technic for transplantation of the ureter since it is the structure most often transplanted. However, the same technic is applicable for transplantation of the common bile-duct and the pancreatic duct.

The ureter is lifted with an aneurism needle and clamped with a small artery forcep as near the bladder as possible. While the ureter is held up with the forcep a suture of fine silk (No. 0) threaded with two needles (No. 12) is placed in the anterior surface of the proximal segment, close to the forcep (Fig. 1, a). This suture is tied and used for traction while the ureter is being cut proximal to the forcep. The distal segment of the ureter is tied with catgut and allowed to drop back. The proximal end of the ureter is held up with the suture and its end split for a distance of about one

centimetre as close to the suture as possible (Fig 1, *b*) One end of the suture is held while the other is passed behind the ureter and inserted through the wall, into the lumen at the opposite corner, then out again, and locked (Fig 1, *c*) Thus, when traction is made on each end of the suture, the corners, made by splitting the end of the ureter, are held wide apart (Fig 1, *d*)

*Preparation of Bowel*—At a point on the rectum easily approximated by the ureter, two mattress sutures of fine silk are placed parallel to each other and separated by about the width of the ureter These sutures are placed slightly diagonal to the long axis of the bowel, so as to correspond to the normal course of the ureter as it will enter the bowel The rectum is then

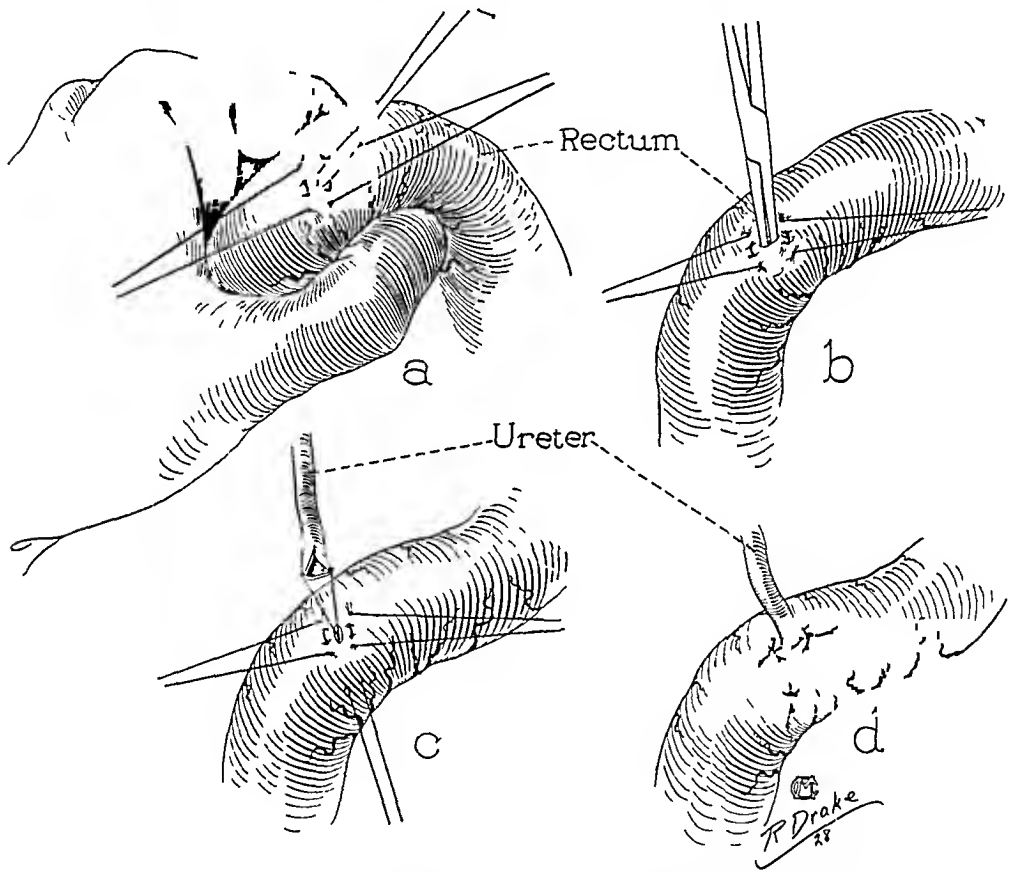


FIG 2—Technic of preparing bowel and transplantation of ureter

lifted and a stab wound is made directly between the two mattress sutures (Fig 2, *a*) A small mosquito forcep is inserted through the stab wound and the blades separated slightly to allow the mucosa to pout up through the wound (Fig 2, *b*)

*Implantation of Ureter*—The two needles, attached to the previously prepared ureter, are now taken one at a time and passed through the stab wound into the lumen and out again through the wall of the bowel about two centimetres beyond the stab wound These are inserted in such a way that the split end of the ureter is brought against the wall of the bowel Traction on these sutures draws the ureter into the lumen of the bowel, and when

they are tied it is held firmly in place (Fig 2, *c*) The mattress suture on each side of the ureter is then tied, which causes dimpling of the wall of the bowel, inverts the mucosa and holds the ureter firmly

Results following this simple procedure have been very satisfactory Some of our animals have lived for several years with transplanted ureters and others with transplanted common bile-ducts We have found, however, that the kidney is rarely normal after transplantation of its ureter, regardless of the method used The liver also shows definite lesions after transplantation of the common bile-duct On the other hand, the transplantation of the pancreatic duct is almost always successful and the gland usually remains normal

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### AN APPARATUS FOR CONTINUED ADMINISTRATION OF FLUIDS INTRAVENOUSLY\*

IN 1924, Matas administered fluids intravenously in the treatment of patients following operation to help to ward off shock, toxæmia and exhaustion, and in order to replace slowly the fluids which had been lost by dehydration Since that time many types of apparatus have been devised for the intravenous administration of fluid

The apparatus I am describing, unlike many that are used in the gravity methods, is not expensive, and it can be assembled from tubing and bottles found in almost any laboratory It consists of a bottle of a capacity of about 2 litres with graduations in 50 and 100 cubic centimetres (Fig 1), two right-angle bent glass tubes, one long and one short, a long-stemmed funnel, a Murphy drip bulb without a hole for air, about four feet of rubber tubing, and an intravenous needle The two pieces of bent glass tubing and the long-stemmed funnel are inserted through a rubber stopper (Fig 1, *a*) which fits tightly into the neck of the bottle The stem of the funnel and the long arm of the longer bent tube, *b*, pass to the bottom of the bottle The shorter right-angle tube projects only a short distance within the neck of the bottle The other arm of this shorter right-angle tube has a small fusiform enlargement into which cotton may be packed, it thus acts as a vent to admit air but will not allow contamination of the content of the bottle To the shorter arm of the longer bent glass tube is attached a piece of rubber tubing about one foot long, of the type which is ordinarily used in administration of fluids intravenously At the other end of this piece of tubing is attached a drip bulb, *c*, which does not have a hole in it to admit air A second piece of rubber tubing runs from the lower end of the Murphy drip bulb to the needle by which the fluid is to be administered The needle may be of the ordinary intravenous type, with any of the modifications which are recorded in the

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\* Submitted for publication October 22, 1931

literature of today, for instance, it may be a gold needle which does not corrode easily. It may have a shield for support, and, as has been suggested by Matas,<sup>2</sup> it may have lateral openings in its shaft as well as the terminal opening, this latter feature is an added advantage although not wholly necessary.

The bottle, the tubing, and the needle are sterilized in an autoclave. The fluid to be used is then poured into the bottle through the long-stemmed funnel. A piece of sterile gauze is placed over the funnel and held in place by a rubber band. Because the apparatus works by means of a siphon, a bulb, *d*, is used to set the fluid in motion. The bulb is of the kind commonly

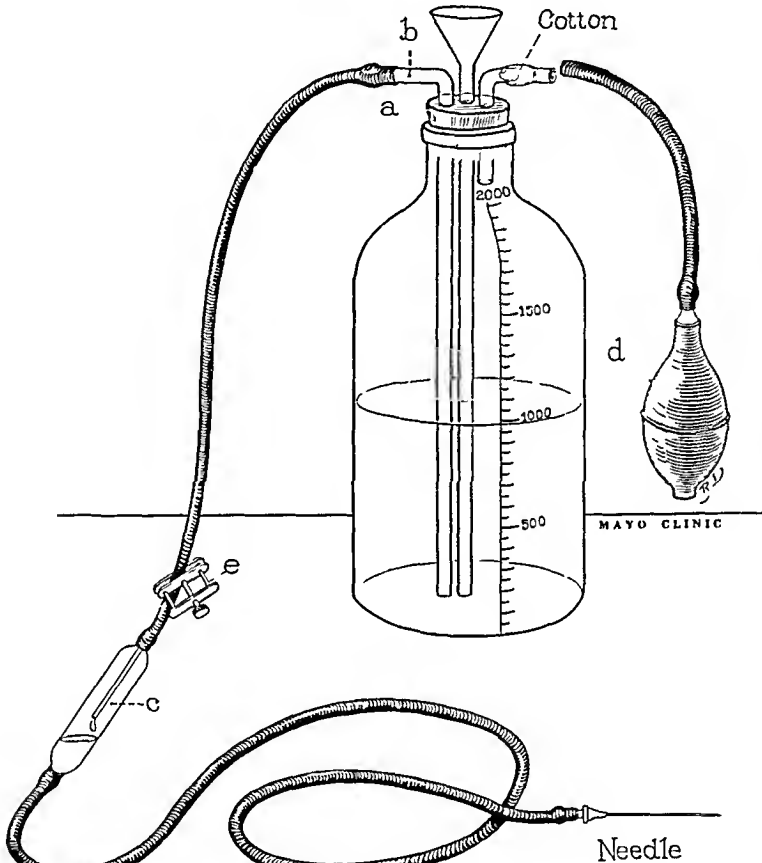


FIG 1—A simple apparatus for continued administration of fluids intravenously

used in any apparatus for testing blood-pressure. This is attached to the small, right-angle tube, and slight pressure is exerted on the bulb, causing the fluid to rise in the funnel and in the long right-angle glass tube. Since the tube is at a lower level than the funnel (Fig 1), the fluid soon spills over and runs out of the drip and distal end of the tubing to the needle. The bulb is then disconnected, leaving the smaller glass tube as an air intake. The bottle is placed at a level of about one foot above the forearm or leg into which the fluid is to be injected so that the fluid may flow more readily, aided by gravity. The needle is then inserted into the vein, choosing a place on the limb which is relatively free from motion. The needle is strapped in

## HÆMORRHAGE INTO A PITUITARY BODY

place by means of adhesive tape placed across its shaft, above its point of insertion. A small piece of sterile gauze is fastened so that it rests over the point of insertion of the needle. The tubing is also fastened to the limb for a distance of about 6 to 8 inches proximal to the point where it is connected to the needle. If a place has been chosen well away from a region where there is motion, as near a joint, there is no need for further immobilization of the limb. If, however, it has been necessary to choose a vein close to a joint, it may be wise to immobilize the part while the apparatus is in use. A very efficient method for immobilization is wrapping an ordinary pillow around the limb.<sup>1</sup> This prevents motion and is much less tiresome than a firm splint. The apparatus is set running at about 50 to 60 drops for each minute and can be left unattended for a considerable time. The rate of flow through the drip is controlled by a small clamp, *c*, which is placed just above it. A warming device, as a hot-water bottle, may or may not be used. It has been shown that fluids can be given slowly at room temperature without ill effects. Three to four days has been about the longest period found necessary to use the same vein. It is often well to open the clamp on the tubing about every six to eight hours in order to allow the fluid to run more rapidly and to prevent stasis, which encourages the formation of thrombus around the point of the needle.

The apparatus has proved satisfactory in administration of a large amount of fluid within a short time. From 5,000 to 6,000 cubic centimetres or more may be given in twenty-four hours with little, if any, discomfort. It is well known that patients frequently experience much discomfort from the hurried administration of 1,000 to 2,000 cubic centimetres of fluid.<sup>3</sup>

The apparatus has been used effectively also for continuous lavage of the bladder after operative procedures to keep the bladder free from blood-clots.

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<sup>2</sup> Matas, Rudolph. The Continued Intravenous "Drip". *ANNALS OF SURGERY*, vol. LXXIX, pp. 643-661, May, 1924.

<sup>3</sup> Penfield, W. G., and Tephitsky, David. Prolonged Intravenous Infusion and the Clinical Determination of Venous Pressure. *Arch. Surg.*, vol. VII, pp. 111-124, July, 1923.

## HÆMORRHAGE INTO A PITUITARY TUMOR FOLLOWING TRAUMA

THE question of the relationship of trauma to the initiation or aggravation of all types of disease is one that is more and more demanding the attention of physicians and industrial boards. Where the pathological processes that may follow trauma are clearly understood, court decisions and awards to



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workmen are, as a rule, well standardized. Where there is little information regarding the pathological processes that may follow in the wake of trauma, medical as well as court decisions are at great variance, disputed, and often proven incorrect by subsequent events or the lapse of time.

So clearly seems the relationship of trauma to hæmorrhage into a pre-existing pituitary tumor or cyst in a workman recently seen that it may be of interest to call attention to the possibility of this. Description or pathological material itself demonstrating traumatic hæmorrhage into brain tumors in general is very meagre. Still more rare are specimens of hæmorrhage,



FIG 1.—X ray of skull showing much enlarged sella turcica

traumatic in origin, into pituitary tumors. Spontaneous hæmorrhage into pituitary tumors must, however, be fairly common as an accompaniment of degeneration of tumor tissue. Hæmorrhage into normal pituitary gland tissue following severe trauma such as fracture of the skull is fairly well known. Cushing illustrates one case and quotes another where marked hypopituitary symptoms followed severe head injury.

The author has seen in Doctor Cushing's clinic an instance of aggravation of ocular symptoms associated with a pituitary tumor which followed a blow over the temporal region. At operation the tumor was found to be largely destroyed by hæmorrhage into its substance. Doctor Cushing has kindly

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permitted me to refer to this case and also to a specimen in his collection of an extensive infiltration of blood into a pituitary tumor following trauma. At autopsy this seemed to be the sole cause of death. This hæmorrhagic infiltration into the pituitary tumor followed a fall. A review of the literature (by title) on pituitary tumors for the past twenty years fails to reveal any contributions on this subject.

CASE—E. C., hospital No. 45075. The patient, aged twenty-eight, was referred to the Strong Memorial Hospital by Dr. T. H. Farrell, of Utica, New York, because of blindness of the left eye and failing vision in the right. His past history was entirely irrelevant. The patient repeatedly stated that he had never had any disturbance of vision prior to the present illness.

In September, 1930, some five and one-half months prior to entry, the patient was struck in the left eye by a fist. He was "dazed" for a few moments but did not have any other general symptoms. The periorbital tissues became rapidly swollen and ecchymotic and the lid could not be opened for two or three days. So far as he is aware the sclera or conjunctiva itself was not discolored. When the patient was again able to open the left eyelid he noted a marked blurring of vision on the left. Total blindness in the left eye ensued, in about five to six weeks. Vision in the right eye was then noted to be less acute than formerly. He himself noted that vision in the temporal field was gradually being encroached upon. This progressed steadily until he had a complete loss of temporal field vision and probably central vision as well.

At no time did he experience any headache. There likewise have not been any "neighborhood" symptoms. Sexual powers, never very great, had not been altered.

There was not to be obtained a history of symptoms suggesting that he had had a subarachnoid hæmorrhage at the time of the injury. He was a well-developed and nourished male who had none of the usual appearances of acromegaly or marked hypopituitary disease. The skin was normal in texture. Distribution and amount of hair were not unusual.

Neurological examination was entirely within normal limits except for the ophthalmological examination. Both pupils were dilated, equal and round. Pupillary reaction to light was absent on the left side, the right side being normal. Light stimulus to the right retina was associated with contraction of the left pupil. The reverse was not

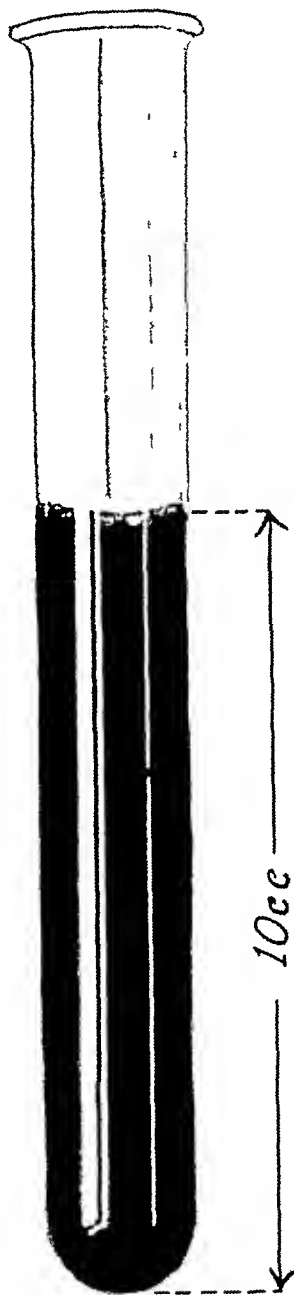


FIG. 2—Actual size drawing of test tube containing fluid from pituitary cyst.

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true Extraocular movements were normal Both optic nerve heads showed fairly marked pallor It was more marked on the left, however Visual fields showed a complete loss of vision on the left The central vision as well as the temporal field vision on the right had been lost Visual acuity was 20/200 on the right side

X-rays of the skull showed a marked enlargement of the sella turcica with erosion of the posterior clinoids and a thinning out of the floor of the sella (Fig 1) X-rays of the hands were taken for a question of "tufting" of the terminal phalanges but none was demonstrated

Laboratory examinations were within normal limits The urine was normal in amount and gravity (1020) Blood smears and blood counts were normal Basal metabolic rate was -18 per cent A sugar-tolerance test showed a normal curve Fasting blood sugar was 70 milligrams per 100 cubic centimetres One hundred grams of glucose were given by mouth A blood-sugar reading one-half hour later was 130, one hour—120 milligrams, one and a half hours—68 milligrams, two and a half hours—70 milligrams, three hours—100 milligrams

*Operation*—A right frontal craniotomy was performed under local and ether anaesthesia The dura was cut along the great wing of the sphenoid on the right side and the region of the pituitary gland exposed without difficulty The right optic nerve was identified and seen to be quite flattened by a tumor mass beneath it The left optic nerve could not at first be seen A needle was introduced into the substance of the tumor and about 10 cubic centimetres of chocolate-brown fluid aspirated (Fig 2) The walls of the cyst collapsed at once The left nerve could then be easily seen stretching like a thin ribbon over the capsule of the tumor The top of the cyst wall was removed for a specimen

The cystic fluid was examined for remnants of tumor tissue but none could be identified Cholesterol crystals in the fluid could not be made out on microscopical examination

The post-operative course was uneventful Vision in the left eye remained nil during the hospital stay The visual field on the right side widened out so that central vision was present and acuity had returned to 20/60

The enlargement of the sella turcica shown by X-ray would seem to be far more than could have taken place in a period of five to six months In all probability the patient had a very slowly growing tumor that may have been present for years The lack of headache at any time prior to injury would also argue for its slow growth Whether or not this had been large enough to cause any visual-field impairment is impossible to say An ophthalmological examination had never been done prior to injury and the patient's powers of observation seemed less than average

*Conclusion*—Haemorrhage into a pituitary adenoma or cyst following trauma, though rare, is a real possibility and may well be kept in mind in considering the differential diagnosis of optic atrophy following head injuries

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## PERONEAL TENDON DISPLACEMENT

### COMPLETE FORWARD DISPLACEMENT OF THE PERONEAL TENDONS DUE TO CALLUS

So far as can be learned from reference to the literature, complete forward displacement or dislocation of the peroneal tendons is rare. As a sequence to callus formation after fracture of the os calcis, this condition has never been reported so far as we can determine.



FIG. 1.—Lateral view, showing the complete forward displacement of the peroneal tendons.

Cotton<sup>1</sup> and Magnuson<sup>2</sup> have each reported a series of old fractures of the os calcis that were operated upon because of one or a combination of the following causes of disability: (1) A resultant traumatic flat foot, *e g*, pronation of the foot and strain on the plantar fascia, (2) loss of lateral

<sup>1</sup> Cotton. ANNALS OF SURGERY, vol. LXXIV, p. 294, September, 1921.

<sup>2</sup> Magnuson. Jour. Am. Med. Assn., vol. LXX, p. 1511, May, 1923.

motion, and (3) excess callus formation—posterior to and beneath the external malleolus. The latter disability was the cause of the forward displacement of the peroneal tendons in the case herewith reported. In their series of cases, neither Cotton nor Magnuson reports finding such a condition previous to or at the time of operation. Magnuson states that "in excess callus formation the peroneal tendons either have been forced entirely away from behind the external malleolus and are held tightly under their pulley ligaments in the groove between the two structures or are caught between the callus and the external ligaments" (Fig 1). In Fig 2, a diagrammatic sketch of our case, can be seen the complete forward displacement of the tendons by the callus formed at the fracture site.

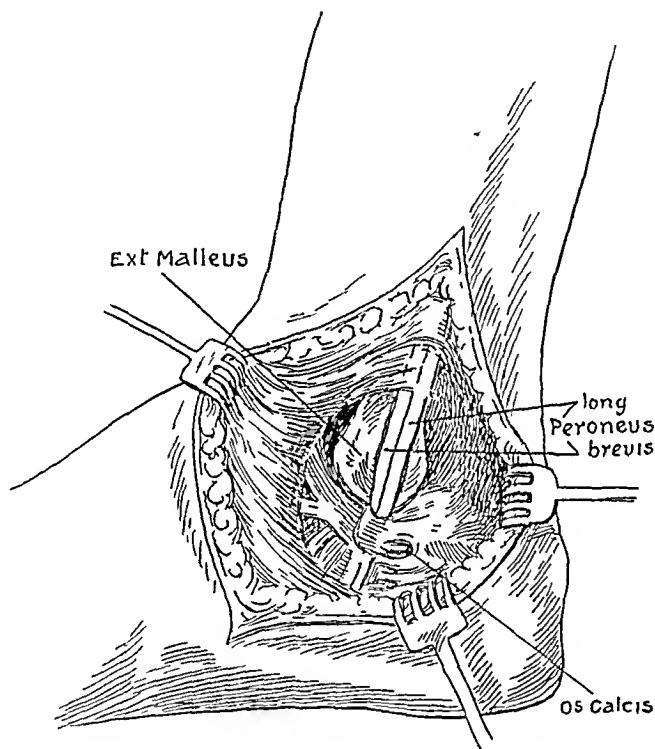


FIG 2—A diagrammatic sketch showing the complete forward displacement of the peroneal tendons due to callus formation.

**CASE REPORT**—A middle-aged man fell from an eight-foot scaffold, landing on his heels on a concrete floor. Rontgenographical examination showed a comminuted fracture of the left os calcis. The foot and leg were put up in a Bohler screw traction apparatus and a plaster case was applied. A fairly good result was obtained, but after nine months the groove posterior to and beneath the external malleolus had largely filled with callus displacing the tendons (Figs 1 and 2).

There is a very apparent widening of the ankle entirely due to the forward displacement of the peroneal tendons until they occupy a position in front of the external malleolus.

The removal of the excess callus and replacement of the peroneal tendons was done after the technic of Magnuson.

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## HEPATICO-GASTROSTOMY

THE operation of anastomosing the hepatic duct with the stomach has been done only in a limited number of cases. Nature, in a few instances, has performed the operation of cholecystogastrostomy herself when the presence of a gall-stone in the gall-bladder has set up a pericholecistitis with adhesions of the fundus to the stomach. The gall-stone has then ulcerated through the walls of the stomach, thus producing a biliary fistula allowing the bile to pass directly from the liver into the stomach via the hepatic duct and gall-bladder. Deaver, in his *Surgery of the Upper Abdomen*, 1914, cites the following case: "Upon opening the abdomen, found duodenum and pylorus bound by strong adhesions to fundus of gall-bladder and lower surface of liver. On releasing adhesions, a perforation of stomach and of gall-bladder was found with a large gall-stone protruding into stomach."

Various methods have been employed for connecting the hepatic duct to the intestines when the gall-bladder and common duct have been removed, either because of cancer or traumatism.

Hepaticostomy was first done by Kocher, in 1889, when he sutured the stump of the hepatic duct to the skin for the purpose of drainage. The patient lived seven days. A similar operation was made by Sandler, which he called hepatostomy, wherein the hepatic ducts were entirely occluded, thus preventing any bile being excreted. In this case, the dilated intrahepatic bile channels projected from the surface of the liver in the form of small cysts. Sandler introduced a trocar into one of these cysts, inserted a drainage tube, brought the tube to the surface and stitched it to the skin—thus he established liver drainage.

It was Hildebrandt who introduced the operation of cholecystogastrostomy, and was therefore the first surgeon to demonstrate that the presence of bile in the stomach produced no bad effects. That operation has been done many times since. Various operations have been devised and successfully performed for anastomosing the hepatic duct with the intestines, either duodenum or jejunum—hepatico-enterostomy. These methods, however, have the common objection that infection is likely to travel upward from the intestines.

There is no record earlier than 1914, which the writer has been able to find, wherein the hepatic duct has been implanted directly into the stomach.

Deaver, in his work of that year, says

"The use of the jejunum in such circumstances (hepatico-enterostomy) is objectionable, but if an anastomosis can be made with the stomach this should be done." But he mentions no instance where it had ever been done, save one Wilms (Brandt, *ibid*, Fall 4) where a biliary fistula resulted from an injury to the common duct at a previous operation. Three succeeding operations failed to correct the fistula. In a fourth operation, he connected the hepatic duct to the stomach by a rubber tube which was subsequently vomited, necessitating a fifth operation. This was successful.

Since 1914 a number of hepatico-gastrotomies have been reported with varying degrees of success. Tschassownikoff (*Zur Frage über die "Hepato-Cholangiogastro- bzw. enterostomia"*)—Operation [Hepato-cholangiogastro or enterostomy] *Zentralblatt für*

## BRIEF COMMUNICATIONS

Chirurgie, vol 11, pp 2082-2083, 1924) reports a case wherein he prefaces his report of the case in these words "This operation belongs to the very rare operations, and is only employed in congenital, benign or malignant occlusion of the hepatic duct, as soon as one does not succeed in removing the obstruction by way of the porta hepatis

"This operation, 'choleangiogastrostomy,' was performed in the surgical clinic of Odessa in order to close a biliary fistula, and to remove an impermeability of the ductus hepaticus"

In the Journal of the American Medical Association, April 14, 1931, Waltman Walters, Rochester, Minnesota, presents an article under the head of Complete Stricture of the Common and Hepatic Ducts, Treated by Transplantation of the External Biliary Fistula into the Stomach or Duodenum In this article, the author quotes W J Mayo, who, in 1905, made an accurate anastomosis between the stump of the common duct and the duodenum Dr F H Lahey reports in the ANNALS OF SURGERY, June, 1923, of establishing an external biliary fistula for duct obstruction, and subsequently transplanting this fistula into the stomach or duodenum

Dr Howard Lilicthal reports a similar operation, ANNALS OF SURGERY, June, 1923, and Hugh Williams also reports his method of transplanting a biliary fistula into the first portion of the duodenum

Walters has collected only twelve cases of successful transplantation of biliary fistulae into stomach or duodenum

Wickhoff and Angelsberger (Berlin klin Wchnschr, vol vi, p 138) were the first to perform cholecystogastroenterostomy, Jacobson having collected seventeen cases of this nature from literature But in all these cases the gall-bladder was employed to make the anastomosis

The object in reporting the following case is First, because it presents some interesting features relative to obtaining temporary relief from so distressing a condition as advanced cancer of the gall-bladder and common duct, and, second, to show the priority, so far as any literature shows, of the method employed Up to the date of this operation, 1914, it had not been demonstrated conclusively that bile flowing continuously and directly from the liver into the stomach would cause no serious disturbance to the latter, second, that when the bile is so delivered it functions just as normally as when emptied into the intestine, third, that during the period of fifty-four days from the establishing of a fistula from the hepatic duct to the surface of the skin, there was no appreciable disturbance of digestion, although not a particle of bile was flowing into the intestine

The case is as follows

Mrs P, aged seventy-six years, widow, one child Mother died of "shock" at advanced age, had been an invalid for two years prior to death suffering from dysentery Father died of "bowel trouble" at eighty years of age

Previous health of patient, good, no serious illness, had one attack of "bowel trouble" which was of short duration Said she occasionally had bilious attacks Had led a very active life She was deeply jaundiced, stools clay-colored, urine highly bile-tinged, tongue coated—complained of constant pain upper right quadrant, but never had had pain of biliary colic type, marked fatigue, no temperature, emaciation, no appetite

A distinct tumor in the upper right quadrant could be palpated It was not markedly sensitive to pressure

With the hope of giving temporary relief, the patient was taken to the Deaconess Hospital, Boston, and operated on April 25, 1914

# HEPATICO-GASTROSTOMY

A right lateral incision disclosed a cancerous mass involving gall-bladder, glands and common duct to within a short distance of the ampulla. The gall-bladder, the cystic

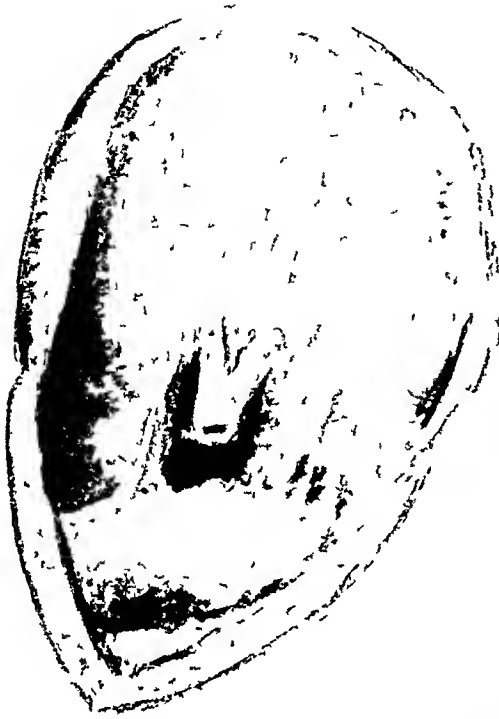


FIG 1—The gall bladder and common duct have been removed. The short stump of the hepatic duct protrudes from the liver

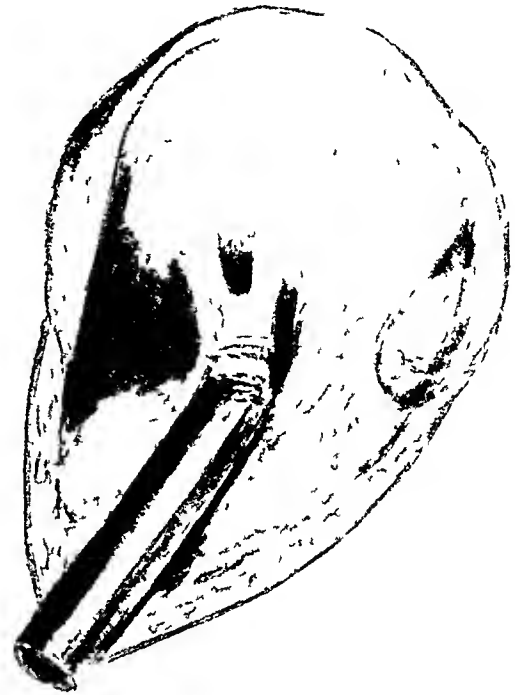


FIG 2—A rubber drainage tube has been sutured to the stump of the hepatic duct and the free end brought out of the incision



FIG 3—Fifty four days later. The fistulous tract left after removal of the rubber tube appears in an elongated hepatic duct

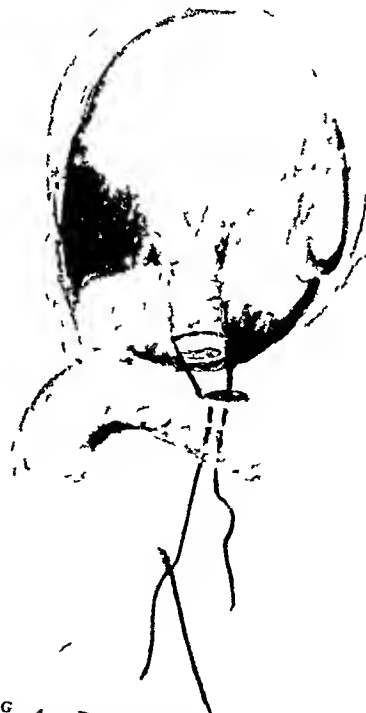


FIG 4—Button hole opening made in stomach wall near pylorus. Stomach transfixed with sutures for the purpose of drawing the elongated duct into the button hole opening

duct and the greater part of the common duct, together with involved glands, were removed. The removal of the above-mentioned structures left a short end of the hepatic



duct protruding from the liver, and the remaining portion of the common duct (Fig 1) From the stump of the hepatic duct clear bile was seen flowing Over this hepatic stump a rubber drainage tube was sutured (Fig 2), brought to the surface, a tissue drainage inserted alongside of the rubber tube leading down to the duct The remaining portion of the common duct was ligated near the duodenum The incision was then closed Before the dressings were applied, bile was already flowing from the rubber tube

Patient made a good recovery and left the hospital much improved The rubber tube was removed at the end of two weeks Her jaundice had practically cleared up, urine normal, but of course her stools were still clay-colored, as it was not possible for any bile to find its way into the bowel

By June 18 she had improved to such an extent that it was deemed best to make an attempt to divert the bile from the rubber drainage tube into some channel whereby it could reach the intestine She was again taken to the Deaconess Hospital and a second operation was done Nature had constructed a very satisfactory fistula (Fig 3) leading from the stump of the hepatic duct to the surface, which had acted perfectly in draining



FIG 3—Elongated hepatic duct sutured into the stomach

the bile from the liver This fistulous tract was carefully dissected free from surrounding adhesions The question next to be decided was to what structure should the fistula be anastomosed to get the best results Fearing infection, should the connection be made either with duodenum or jejunum, the pyloric end of the stomach was chosen, particularly as that portion of the stomach lay in close proximity to the liver and some adhesions thereto had already been formed

A buttonhole opening (Fig 4) was then made in the stomach wall nearest the free end of the fistula The stomach wall was then transfixed with a straight needle, threaded with linen, at a point opposite the buttonhole opening The needle was made to emerge through this opening, the end of the fistula transfixed with the linen, and the needle made to emerge at the point of entrance, sufficient traction was then made to draw the fistula well into the stomach opening (Fig 5) Here it was firmly sutured, a fold of omentum was laid over the suture line and stitched to the stomach wall for protection against leakage The stomach was further anchored to the under surface of the liver, wound closed with drainage

The patient made an excellent operative recovery Drain removed in forty-eight

## DISLOCATION OF PATELLA

hours. Wound healed primarily. She vomited bile a few hours after she reached her room but none thereafter. On the third day there was a normal bowel movement, showing a distinct bile stain in the stool. No returning jaundice, good appetite, gain in strength. About July 10 she again showed signs of jaundice, although her stools had a good bile tinge. No vomiting and good appetite. There was every evidence that the anastomosis between hepatic duct and stomach was perfect, as the stools continued normal in color. She died August 14, 1914. No autopsy allowed. Cause of death given as metastasis into liver.

Thus the practicability of a hepatico-gastrostomy was established. If the operation has been performed in just this manner prior to 1914 no record of it has been found.

*Boston, Mass*

DEWITT G. WILCOX, M.D.

## TRAUMATIC LATERAL DISLOCATION OF THE PATELLA

TRAUMATIC dislocations of the patella are seen rather infrequently. Even among industrial accidents, of which there are at present a large number, one rarely comes across an instance of dislocation of the patella that is not part of a more extensive and more serious injury to the knee. Four factors commonly predispose to an outward dislocation of the patella: (1) laxity of the quadriceps muscle, (2) contracture of the iliotibial band and the external lateral patellar expansion of the quadriceps aponeurosis, (3) under-development of the lateral condyle of the femur, permitting abnormal outward mobility of the patella, and (4) outward rotation of the leg. Any one or all of these conditions may be involved in the mechanism of a given case of outward dislocation of the patella.

In my case, the patient had had anterior poliomyelitis, as a result of which he had a flexion deformity of the knee, weakness of the quadriceps muscle, shortening of all the soft tissues on the outer aspect of the knee and thigh, a marked knock-knee, and a fixed outward rotation of the leg. Therefore, a moderate trauma, caused by a fall, was sufficient to push the patella outward.

Dislocation of the patella is said to occur when the knee is in either hyperextension or flexion. In hyperextension the patella has been pulled up above the external condyle, which no longer acts as a barrier to outward movement of the patella. When the knee-joint is flexed the patella lies over the lower articular surface of the lateral condyle and can readily slip outward. In my patient the knee was continuously flexed. During the fall the joint became more flexed, so that the patella could be displaced.

My case has the further interest in that the patella was jammed against the condyle so tightly that it was virtually impacted in the femur. Though the patient was seen soon after the injury, manipulation under anæsthesia was not sufficient to reduce the dislocation. Even at the open operation considerable difficulty was encountered in dislodging the patella.

CASE REPORT—Frederic C., colored, twenty-five years old, was admitted to the Hospital for Joint Diseases February 28, 1930. Five days previously he had fallen down five steps, striking the right knee. After getting up he found that he could neither

straighten nor bend the knee. The joint was painful, and soon after the injury it became swollen. At the age of seven years he had had an attack of infantile paralysis. Since then the right lower limb had been weak and atrophied. The knee was slightly bent and the leg was rotated outward. He was unable to bear weight on the right leg. The knee was enlarged, especially in the transverse diameter. The patella was absent in the front, but it was palpable on the lateral aspect of the knee. It was jammed up against the external condyle and was immovable. The iliotibial band was taut. There was a complete outward dislocation of the patella. In addition the patella was rotated  $90^\circ$  on a vertical axis, so that its articular surface was in contact with the lateral surface of the external condyle. The inner border of the patella was directed forward and caught in a groove in the femoral condyle.

Attempts to reduce the dislocation under gas-oxygen anaesthesia were not successful. Apparently the patella was caught in a groove under a ledge of bone, from which position it was impossible to dislodge it.

On the following day a median incision was made on the front of the knee from three inches above the upper border of the patella to the tubercle of the tibia. The synovial lining was found greatly congested and thickened. The patella was external to the condyle. Since the patella could not be pushed forward, a vertical incision was made into the capsule lateral to the patella. The knee was forcibly extended, whereupon the patella could be brought forward and inward into its normal relation with the femur. With the knee extended it was observed that the patient had a marked knock-knee deformity. This evidently contributed to the dislocation. The capsule of the joint was reefed by overlapping the inner margin over the outer. The margins of the capsule were held firmly together by numerous interrupted sutures of chromic catgut. The incisional opening in the outer part of the capsule was covered over with fascia. After the wound was closed, the knock-knee deformity was partly corrected by manual force and the limb was immobilized in a plaster-of-Paris bandage extending from the groin to the toes.

The post-operative X-ray picture showed complete reduction of the dislocation. The patient had an uncomplicated convalescence with return of an extensive range of motion in the knee.

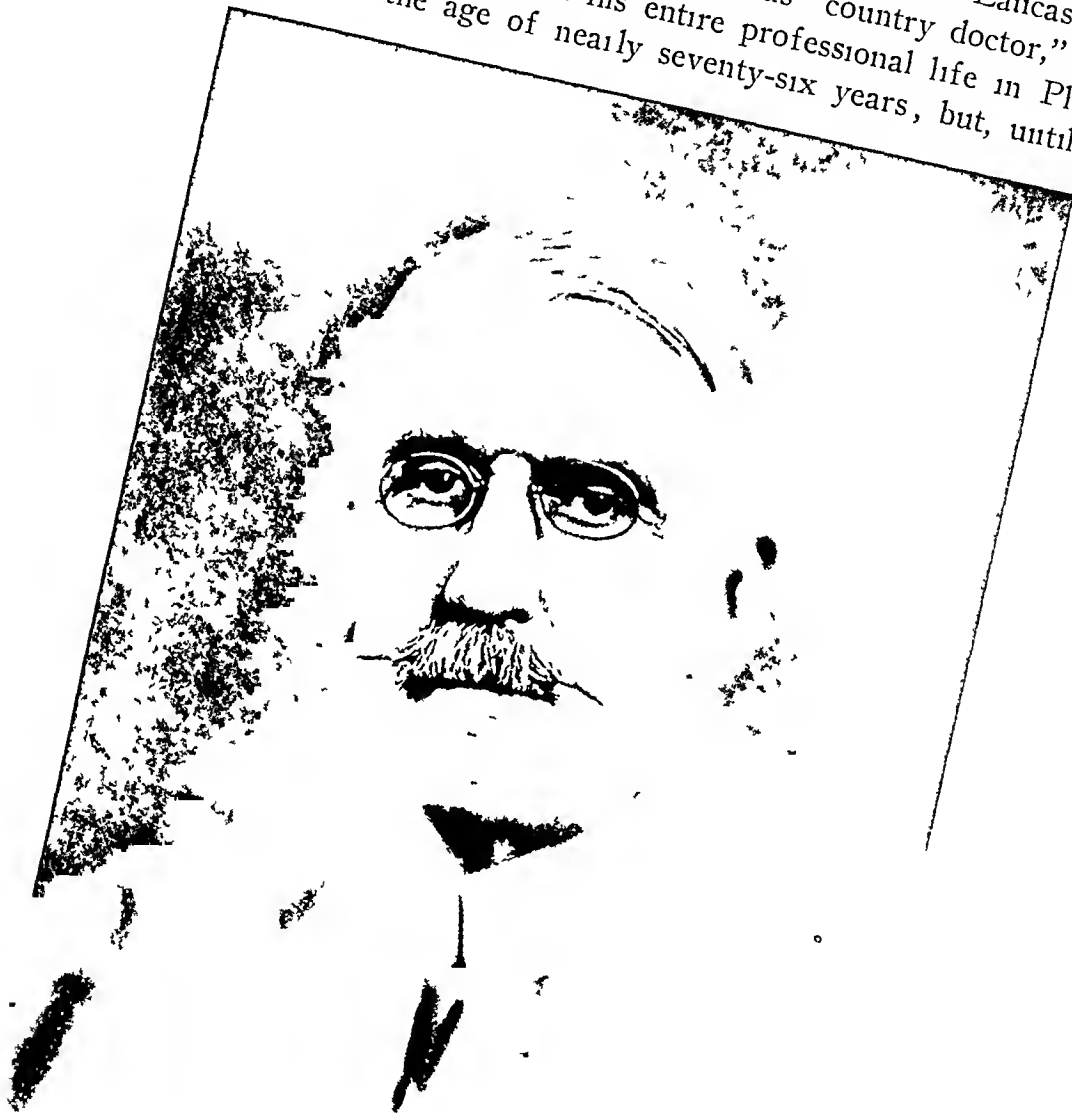
SAMUEL KLEINBERG, M D,  
*New York, N Y*

# MEMOIR

JOHN BLAIR DEEVER, M D

Born July 25, 1855—Died September 25, 1931

DR JOHN B DEEVER was born in a small town in Lancaster County, Pennsylvania, where his father was a famous "country doctor," of Scotch-Irish descent. The son passed his entire professional life in Philadelphia, and died there, at the age of nearly seventy-six years, but, until within a



JOHN B DEEVER, M D

few weeks of his death, "his eye was not dimmed nor his natural force abated." His death was due to an obscure anæmia for which he had submitted to numerous blood-transfusions but for which no cause was found at autopsy.

He was conscious, always, of his lack of an adequate pre-medical education. He received his degree of M D from the University of Pennsylvania

in 1878 He received the honorary degree of Sc D from Franklin and Marshall College, and that of LL D from Villanova College He worked in the anatomical department of his *alma mater* from 1880 to 1899, conducting also large and very successful quiz-classes in anatomy and in surgery, but when, in 1899, his rival, J William White, was given general charge of surgical instruction (during the last illness of Ashhurst), Deaver retired from the University until 1911, when he resumed teaching as Professor of the Practice of Surgery, succeeding White in 1918 as Barton Professor of Surgery His tastes and abilities, however, were not adapted to professorial duties, and, though the age limit for retirement was twice extended in his favor, in 1922 he resigned all active duties at the university, retaining, however, until his death, the title of John Rhea Barton Emeritus Professor of Surgery

Deaver became one of the surgeons to the German Hospital of Philadelphia in 1886, and soon made himself so secure in this position that the other attending surgeons were forced into the background, and in 1896 he was given the title of Chief of the Surgical Department, continuing thus, when at the time of the German war it was thought expedient to change the name of the German Hospital to that of the Lankenau Hospital, after its chief benefactor At the German (afterwards Lankenau) Hospital, Deaver established his Saturday afternoon operative clinics, which became the Mecca for surgeons and students of surgery from all parts of the civilized world, and it is in connection with this clinic rather than with the university that his name will be remembered

Coming to Philadelphia as a country youth, Deaver felt most attracted to Agnew, who also came to Philadelphia as a country youth from Lancaster County, and his career was to a large extent modelled on that of this master surgeon In his later years Deaver became much more robust and looked like a prosperous business man or banker Deaver was regarded as a *radical* in his early years, and he was proud to maintain this reputation to the last Only "the aseptic scalpel" of the surgeon, he maintained, could properly attack the many hidden lesions, especially those of the abdomen, which his own work did so much to bring to notice He was among the earliest and most valiant champions of immediate appendectomy for acute appendicitis He created the phrase "an inch and a half, a minute and a half, a week and a half" to indicate the length of the incision, the duration of the operation, and the stay of the patient in the hospital, when early operation was employed

As an operator, Deaver was rough, ready and radical—a great "slasher" He utterly lacked the patience required for the finer manipulations of many operations, but, in the abdominal cavity, he felt unbounded self-confidence and met accidents (which sometimes occurred) with perfect poise and ready wit As he grew older he became a little more cautious and did not hesitate to declare some cases "inoperable" Though, like Agnew, an excellent anatomist, he never became a really skillful dissector His work at the university in Applied Anatomy was really operative surgery and had only

the most incidental connection with the applications of anatomy to medicine or surgery. He was actually less skillful with his fingers than was his friend and classmate Harte, but he was a better teacher, by telling phrase and lucid demonstration holding throngs captivated hour after hour in his clinic, where he was not wholly averse to "playing to the gallery." Among his favorite catch phrases may be recorded "cut well, get well, stay well," comparing the permanent results of operation with the frequent recurrences encountered after non-operative treatment, and, in relation to officious after-treatment, his frequent plea to his resident physicians to "let the patient get well." He is also largely responsible for that anathema of modern diction, the use of the word "pathology" instead of pathological lesion.

Thus he would ask "What is the pathology", and he would even demonstrate as "the pathology," the lesions uncovered by operation, not understanding that *pathology*, being the science of disease, exists not in the patient but only in the brain of the surgeon.

Though Doctor Deaver found his inability to write English correctly a great handicap, he was not thereby deterred from his ambition to shine as an author, but, like Agnew before him, by associating with himself younger men possessing an adequate pre-medical education he was enabled to appear before the profession as the author of numerous monographs and text-books and of innumerable pot-boilers in the form of addresses on topics of ephemeral if current interest. He was widely sought throughout this country north, east, south and west, as a contributor to State and County Medical Society programs, and he rarely declined these invitations, feeling, as he said, under certain obligations to the physicians who sent their patients to his care. Among his more important monographs should be mentioned

Appendicitis (1896), 4th edition, 1913

Surgical Anatomy, 3 vols., 1899-1903, 2nd edition, 1926-1927

Surgery of the Prostate (1905), 2nd edition, 1922

The Upper Abdomen, 2 vols., 1909-1914, 2nd edition, 1921

The Breast, 1917

Excursions into Surgical Subjects, 1923

Doctor Deaver probably did more operations than has any surgeon in Philadelphia, either before or since his time, though he once said to the writer of these lines "there is no doubt that your father did more operations than anyone else in Philadelphia ever did—why, *he was operating all the time!*"

Deaver's phenomenal physique enabled him to maintain his health and strength in spite of advancing years. He reckoned among the valuable possessions of a surgeon not only those demanded by Lord Moynihan (*the eye of an eagle and the hand of a woman*), but also the *constitution of a mule*. He always took care of his health, never keeping late hours but usually getting to bed by 9 P.M., rising early, and seeing a constant flow of patients in his office until 11 A.M., when he went to the German Hospital and

commenced his operations soon after noon, continuing until all the patients who had been scheduled had been operated on. This sometimes entailed as many as eighteen or twenty-four operations in one afternoon. It is true that he had his clinic so well organized that delays were almost unknown, and the facilities such that three or four operating tables might be in use at the same time. But it should be recorded that Deaver played a lone hand. He bore, "like the Turk, no brother near the throne." He did not use his assistant surgeons for what they were worth. He felt his obligation to the patient and to the family physician, and insisted on doing all the operations with his own hands, though, it is true, in later years, he usually allowed his resident physician to close the incision (practically all his operations were abdominal), and often, after making the incision himself, he would merely place the clamps (for a hysterectomy for instance), and then let the Resident complete the operation. In certain operations he excelled. He was an ardent advocate of Cæsarean section, which he was fond of referring to as "my operation", and in difficult bile-duct operations I have never seen his superior either in this country or in Europe.

Doctor Deaver never took an active part in the administration of the societies to which he belonged. He declined to be nominated as president on the ground that he would be bored to extinction to have to sit through an entire session and listen to long and perhaps dull discussions on subjects better understood by himself than by the speaker, or about which he had no information and did not care to learn. So far as is known the only office he ever held in a Philadelphia society was that of a Vice-President of the Philadelphia Academy of Surgery (1918). In 1921-22 he was elected president of the American College of Surgery. As has been said elsewhere, he was a conspicuous figure in every medical gathering, especially distinguished by his wit, his dramatic method of expression, and his scientific experience. He has "brought down the house" many a time by his repartee. Who does not remember a recent meeting of this Association when he referred to one of his interlocutors as "Lordly Arthur"?

A Fellow of our Association since 1892, he brought to our meetings some of his most valuable work.

1893 Appendicitis	1917 Cholecystectomy, and Prostatectomy
1913 Pancreas	1920 Hysterectomy, and Goitre
1914 Pancreatitis	1921 Gastroenterostomy, and Pancreas
1915 Gall-stones	1922 Peptic Ulcer
1916 Gastric and Duodenal Ulcer	

A P C A

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# ANNALS *of* SURGERY

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## THE REPAIR OF CLEFT PALATE

CONCERNING THE PALATINE INSERTION OF THE SUPERIOR CONSTRUCTOR  
MUSCLE OF THE PHARYNX AND ITS SIGNIFICANCE IN CLEFT PALATE,  
WITH REMARKS ON THE "PUSH-BACK OPERATION"

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THE palate of man varies considerably in length without interfering with normal speech, yet there are limits to its length above or below when speech becomes defective. We are not concerned here with cases of long palates. Our theme is the short palate. A study of cases with shortened palates has been most helpful in changing our previous views as to the correct operative procedure for cleft palate. It has been generally accepted that most cleft-palate patients have a shortened palate. Cleft velum alone and cleft palate which extends as far forward as the anterior palatine foramen are usually shorter than lip-jaw-palate splits.

On studying speech in patients after cleft-palate operations, one is impressed by the fact that the best speech results are obtained in cases in which the velopharyngeal closure is complete. Investigation of the quality of speech after successful cleft-palate operations reveals the fact that the variance in speech is dependent in part upon the variance in length of the palate, the length of the palate controlling to a great extent the efficiency of velopharyngeal closure. The greater the efficiency of this closure the more satisfactory the speech. Insufficiency of velopharyngeal closure is dependent upon the distance between the velum and the pharyngeal wall. Passavant's cushion, which is formed by the pterygopharyngeus portion of the superior constrictor muscle of the pharynx, bulges forward as a distinct ridge in some cases of cleft palate, while in others this cushion is scarcely noticeable. Curious as it may seem, patients with cleft velum (Fig 1) frequently have poor speech results whereas those with complete split palates not infrequently have excellent speech results.

We have had under our care two unfortunate patients in whom there had occurred a complete destruction of the nose, upper lip and turbinate bones. As a result of this extensive deformity, the nasopharynx was completely exposed to view (Fig 2) and velopharyngeal closure could readily be studied. When these patients made efforts to pronounce the non-nasal sound "Ah" one could see that the pharynx was raised by contraction of the pharyngeal elevator muscles, and the velum could be observed as it was raised upward and backward by the levator and tensor palati muscles. A definite circular



constriction of the nasopharynx (Fig 3) was evident. This circular pharyngeal constriction was sphincter-like, similar to the sphincteric action of the sphincter muscles in other parts of the body (Fig 4)

In one of these cases the posterior pharyngeal wall bulged markedly forward exhibiting Passavant's cushion, in the other case the cushion formation was rudimentary. In each case, the sphincteric closure of the nasopharynx was complete. So perfect was this closure that light could not be transmitted into the mouth from a diagnostic lamp introduced into the nasal

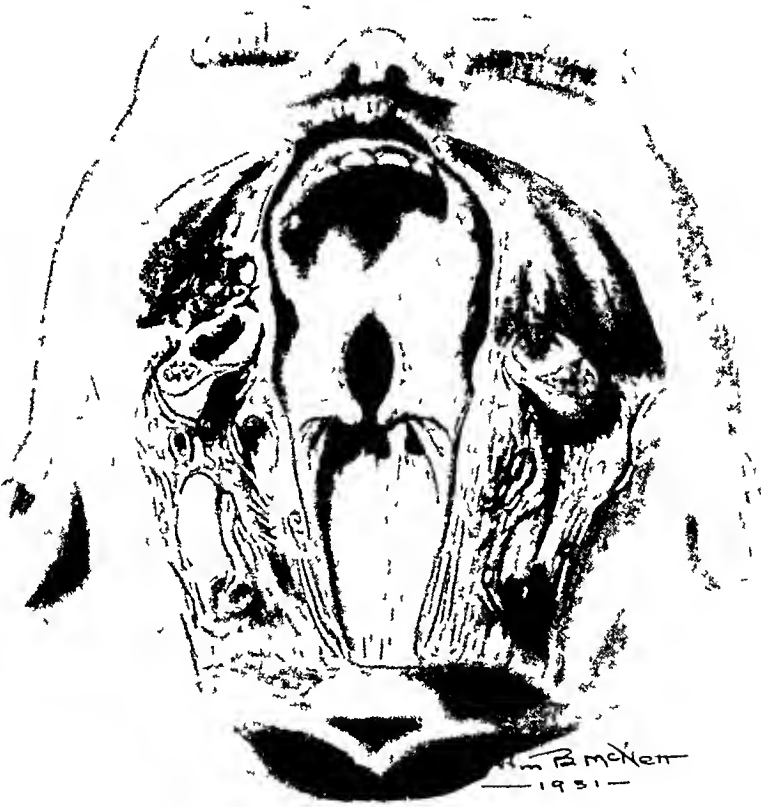


FIG 1—Artist's drawing of a cleft velum in a child about two years old

chambers. This curious yet hitherto unrecognized function of the nasopharynx during speech led to a thorough study of the surgical anatomy of the normal pharynx and that of the pharynx in cleft-palate cases before and after operation. This study was supplemented with a review of the literature.

The standard works in anatomy (Fig 5) have omitted in their descriptions an important insertion of the superior constrictor muscle of the pharynx. This insertion sheds new light on the physiology of the pharynx during speech and explains in part the inability of cleft-palate patients to speak distinctly after cleft-palate operations. Our dissections of the superior

# CLEFT-PALATE REPAIR



FIG 2A—Photograph of the same patient with the nasopharynx exposed. The tongue is raised during this closure. Note that the "palato pharyngeal sphincter" is closed. The closure of this sphincter is complete. Note the "palato pharyngeal sphincter" which is open.

FIG 2B—Photograph of a patient with complete destruction of the nose, upper lip and turbinate bones. Note that the nasopharynx is exposed and the "palato pharyngeal sphincter" is open.

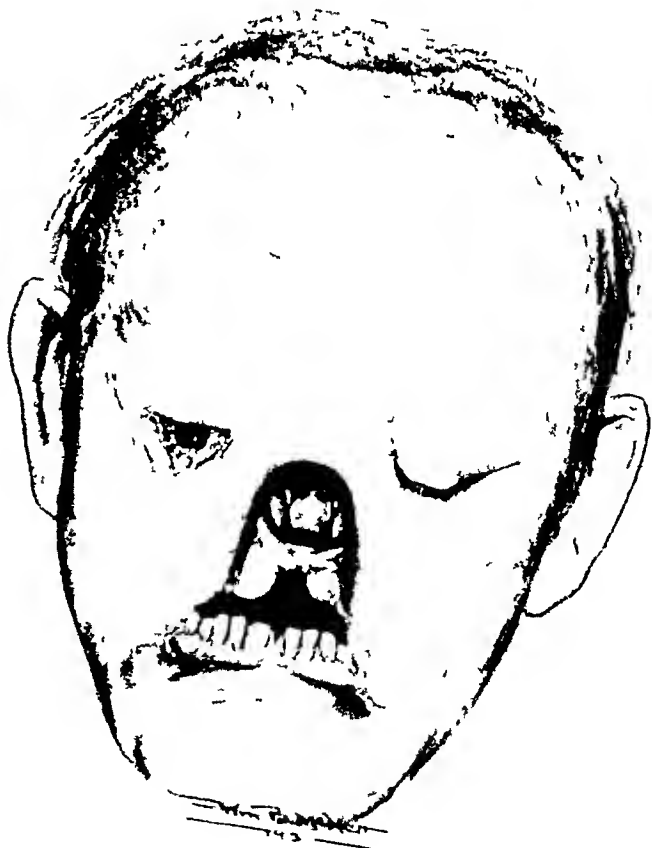
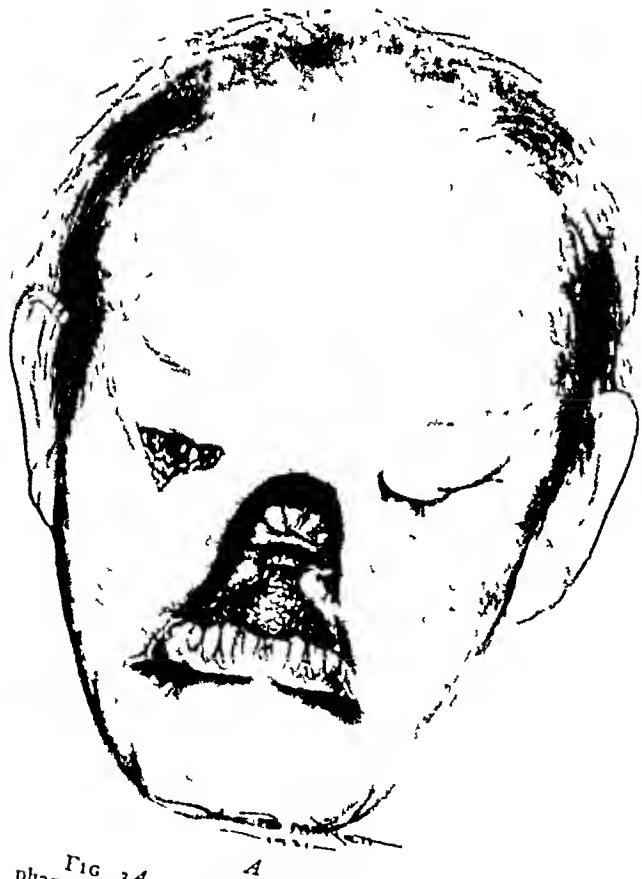


FIG 3A—Artist's drawing of the same patient with the nasopharynx exposed. The closure of this sphincter is complete. Note the "palato pharyngeal sphincter" which is open.

FIG 3B—Artist's drawing of the same patient with the nasopharynx exposed. Note the "palato pharyngeal sphincter" which is open.

constrictor muscle of the pharynx and of the velum, in cleft-palate patients, and in normal individuals proved conclusively to us that this muscle is inserted in an intricate fashion into the nasal surface of the velum at the site of the insertion of the levator palati muscle and that in the normal state the fibres of one side interlace with those of the opposite side, thereby forming a definite muscular ring between the nasopharynx and the oropharynx. This fact unquestionably accounts for the circular sphincteric action seen in the two patients previously referred to

The superior constrictor muscle of the pharynx is composed of the pterygopharyngeus, buccopharyngeus, mylopharyngeus and glossopharyngeus muscles (Fig 6) In addition

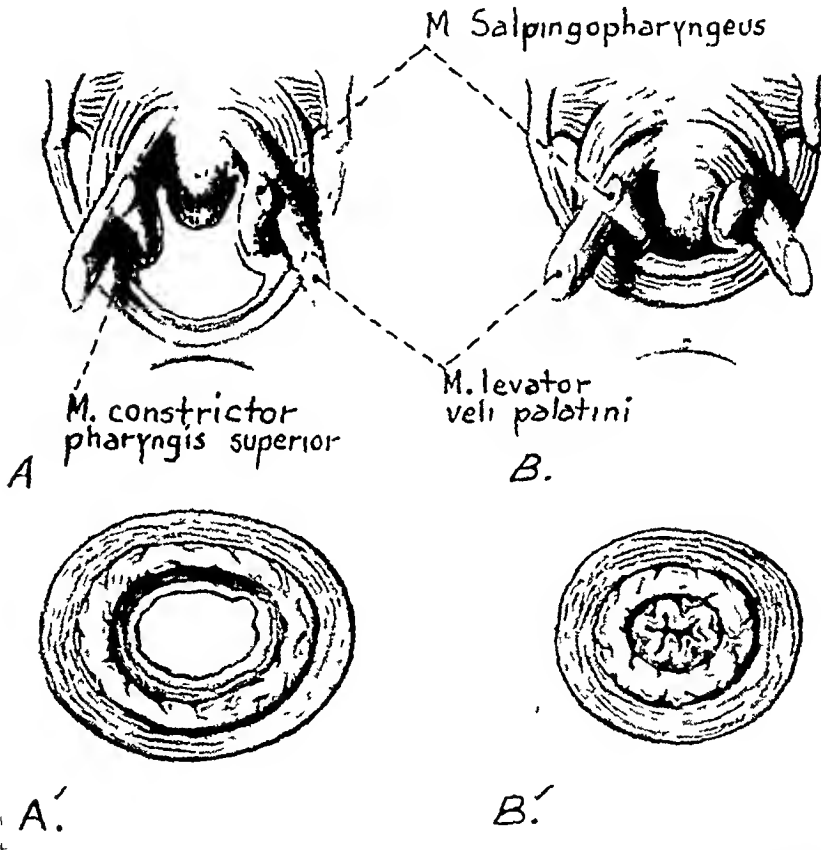


FIG 4.—Artist's drawing of the "palato-pharyngeal sphincter" A—Shows the sphincter open while B depicts it when closed A' depicts the pylorus open while B' shows it closed

it has other accessory muscular slips. These accessory muscular strands when present assist in elevating the pharynx. However, one or more are frequently missing.

The pterygopharyngeus portion arises from the pharyngeal raphe (Fig 7) Starting about 1.25 centimetres to 2 centimetres below the pharyngeal tubercle of the occipital bone, it runs outward towards the pterygoid plate of the sphenoid bone and assumes a curve on each side of the mid-line. As the muscle approaches the mesial pterygoid plate it divides into two slips (Fig 8). The first of these is short and inserts into the lowermost aspect of the posterior border of the mesial pterygoid plate and the hamular process. The longer slip lying mesial to the former runs inward and forward to insert into the palatine aponeurosis with the palatine insertion of the levator palati muscle. The fibres of one side interlace with those of the opposite side at the site of

## CLEFT-PALATE REPAIR

insertion of the levator palati muscles (Fig 9), a site which forms a common blending of the palatal muscles into the palatine aponeurosis. It is this palatine insertion of the superior constrictor muscle of the pharynx which completes the pharyngeal ring, an interesting anatomical fact omitted in the description of this muscle by the anatomists. This muscle which constitutes the upper fasciculus of the superior constrictor muscle of the pharynx forms Passavant's cushion and produces the sphincteric closure between the oropharynx and the nasopharynx.

In passing, we may remark that the pterygopharyngeus portion of the superior constrictor muscle of the pharynx was methodically described in 1863 and 1869 by Passavant, for whom this cushion is named. This cushion

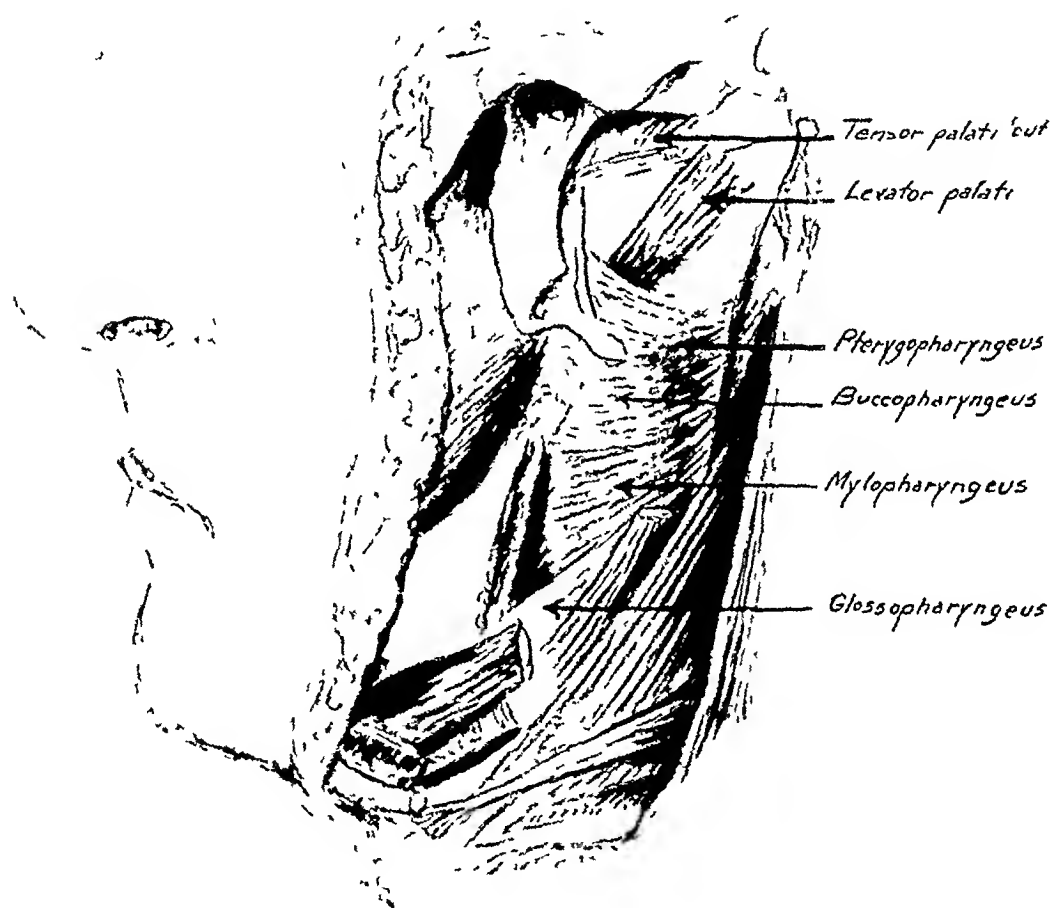


FIG. 5.—The superior constrictor muscle of the pharynx as depicted in the standard works on anatomy. Note that the palatine insertion of the pterygopharyngeus portion of this muscle is omitted.

formation was depicted before in 1805 by Sandifort in the illustrations (Fig 10) appended to his work on deglutition entitled "Deglutitionis Mechanismus, Verticalis Sectione Narium, Oris, Faucium, Illustratus." Czermak, Hyrtl, Merkel, von Luschka and others have studied velopharyngeal closure, but to Passavant belongs the credit for giving the first comprehensive description of this mechanism in the normal and in cleft palate.

In 1879, Voltolini described the sphincteric action of the superior constrictor muscle of the pharynx. He emphasized the fact that the contraction

of the superior constrictor muscle of the pharynx is continued into the palate through the action of the levator palati and palatopharyngeus muscles. In 1880, Falkson discussed the sphincter-like closure of the nasopharynx and agreed with Voltolini on the action of this mechanism. Curious as it may seem, this palatine insertion of the superior constrictor muscle of the pharynx has been omitted from the writings of anatomists. As a matter of fact, physiologists likewise ignored the function of this muscle. We have observed this interesting palatine insertion of the superior constrictor muscle of the pharynx since 1926 and since then we have devoted considerable time and

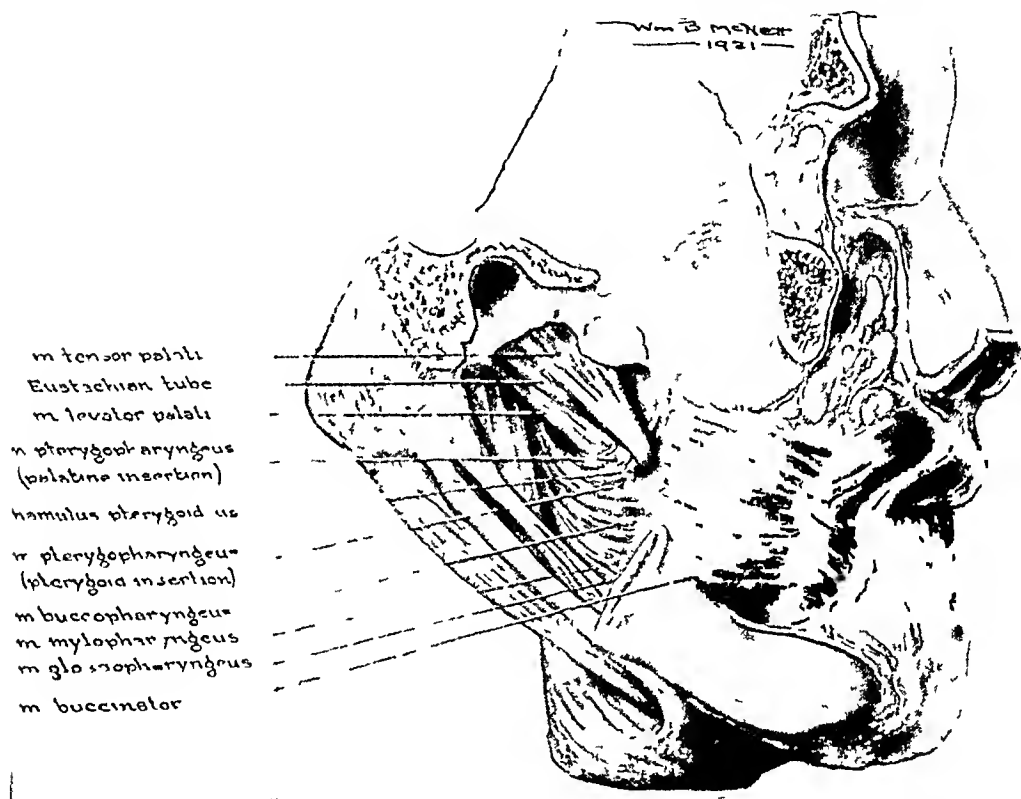


FIG 6—Lateral view of a dissection of the pharynx, showing the pterygopharyngeus portion of the superior constrictor muscle of the pharynx which inserts into the soft palate and the mesial pterygoid plate

study to the subject of velopharyngeal closure. It is difficult to come to a definite conclusion until we were privileged to examine the two patients in whom the nasopharynx was exposed. Since the 'eighties, very little consideration has been given to the pterygopharyngeus portion of the superior constrictor muscle of the pharynx. It is apropos to mention here in this connection Wardill and Whillis, whose anatomical investigations reveal similar observations to our own.

In 1928, Wardill stated "On examination of almost any unoperated case of cleft palate during pronunciation of 'Ah' with the mouth wide open a prominent ridge is seen running transversely across the posterior pharyngeal wall to appear into the upper reaches of the soft palate. Passavant was

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the first to describe this. If the bifid uvula be held aside during this movement, the outer end of the ridge is seen to enter the palate laterally to the muscular belly at the insertion of the levator on that side. The muscle appears to form part of the soft palate and in contracting it might be expected to exert some traction on this structure. This view is compatible with what we know of its function as part of the nasopharyngeal valve or sphincter. Dissections of the pharynx of man and animals have shown this to be correct. With the help of my colleague, Mr James Whillis, the superior constrictor muscle has been shown to arise not only from the usually

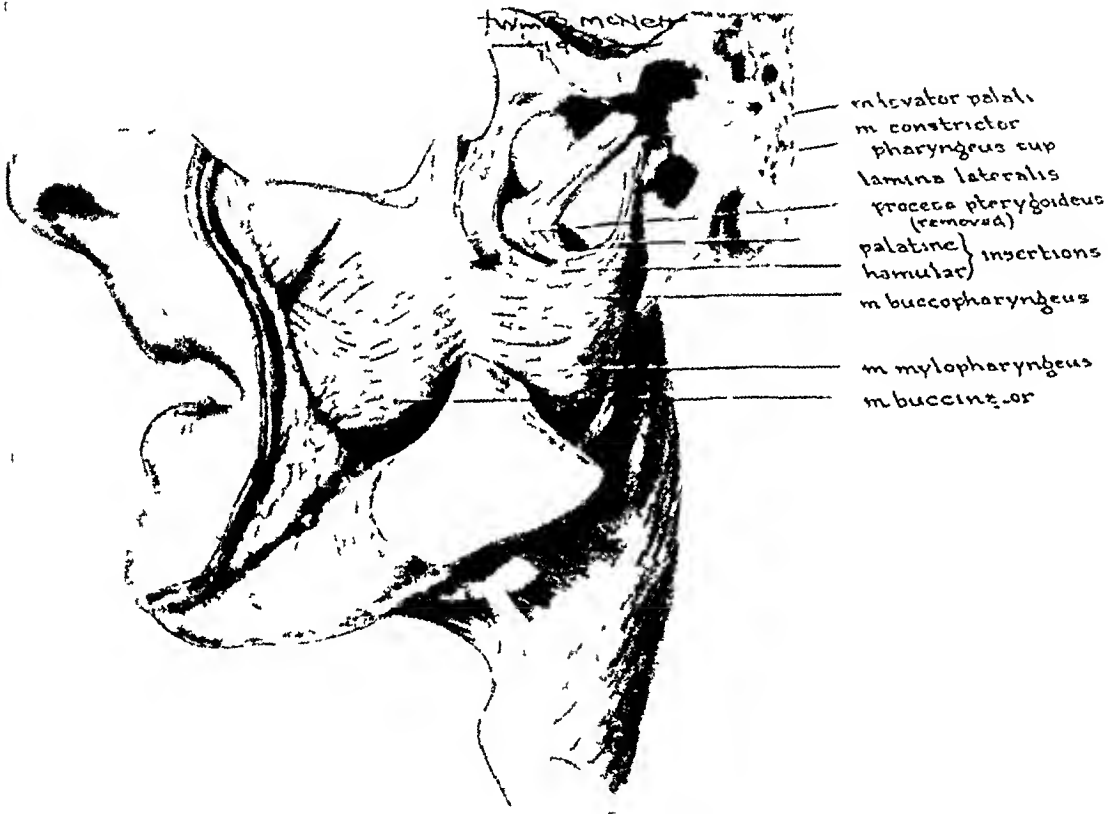


FIG 7—Lateral view of a dissection of the pharynx showing the palatine and pterygoid insertions of the pterygopharyngeus muscle. The lateral pterygoid plate and the tensor palati muscle have been removed.

described situation but also from the palatal aponeurosis, a small fasciculus emanates from this situation to blend with the main portion of the muscle posteriorly."

In his report entitled "a note on the muscles of the palate and the superior constrictor," Whillis suggested in 1930 that "the most suitable name for this muscle, if it merit a place in terminology, is that of a 'palato-pharyngeal-sphincter,' as its action appears to be that it assists in shutting off the nasopharynx by producing the ridge of Passavant, on the posterior pharyngeal wall."

In cleft palate, the anterior segment of the pharyngeal ring is split and the separated ends are spread apart (Fig 11). The cleft palate assumes the shape of a narrow horse-shoe with the opening directed backward. The borders of the defect in this case take the shape of one side of the horse-shoe

with the convexity directed away from the median line. We are led to believe from this that each half of the palate is shortened by a forward and outward pull of the tissue. The dissections of cleft-palate subjects which we have made coupled with our studies of cases after the performance of the von Langenbeck operation convince us that the tensor palati muscle is shorter in cleft-palate cases than in normal individuals. The independent pull exerted on each side by this shortened muscle drags each half of the cleft velum forward and outward, causing the tips of the cleft uvula to point towards the median line. This is especially noticeable when the velum alone

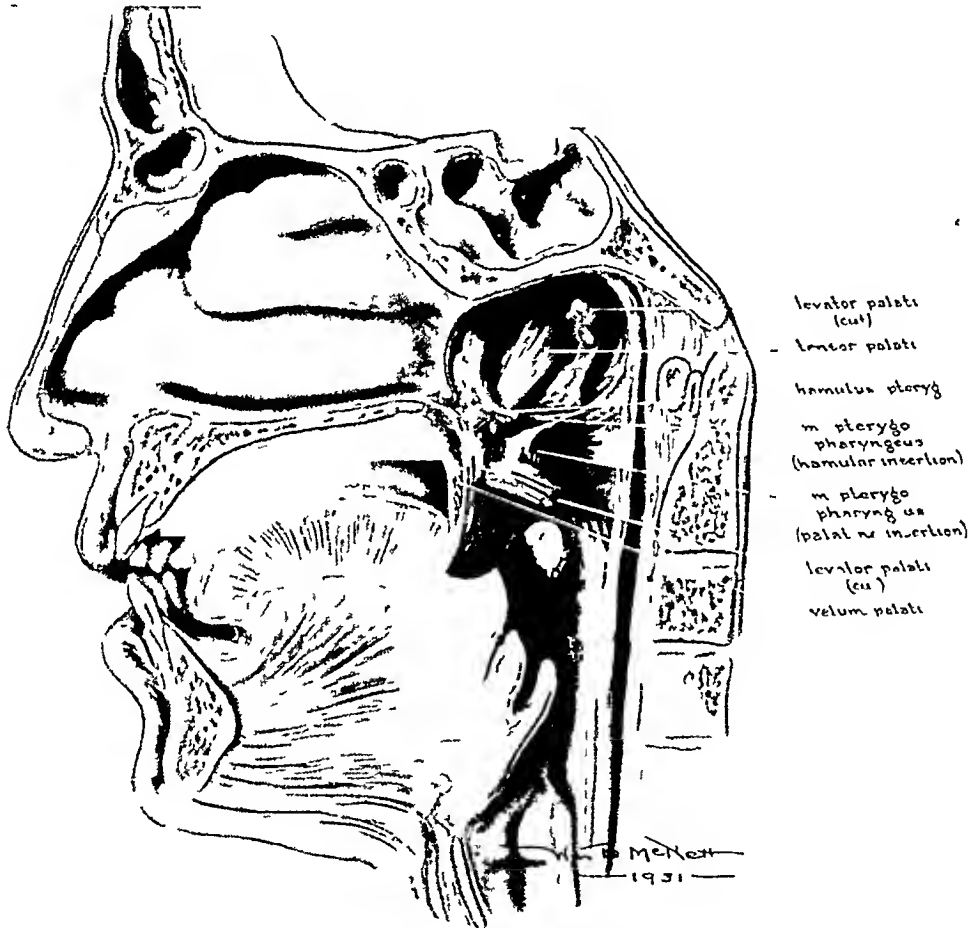


FIG 8—Sagittal section of the head to show the lateral wall of the pharynx. Note the two slips of insertion for the pterygopharyngeus portion of the superior constrictor muscle of the pharynx.

is cleft. Each half of the cleft palate is continuous with the corresponding arm of the cleft pharyngeal ring. The shortening of each half of the velum just mentioned tends to drag the corresponding arm of the pharyngeal ring forward and outward, thereby flattening it on each side and increasing the diameter of the nasopharynx in all directions. The cleft superior constrictor muscle of the pharynx in cleft palate is thus unable to produce the desired sphincteric action between oropharynx and nasopharynx, a function so essential for normal speech.

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While Dorrance divided the hamular process in all his cleft-palate operations since the year 1914 the full significance of the influence exerted by this procedure on velopharyngeal closure was not properly interpreted or appreciated until we made our anatomical studies. Division of the hamular process will release the tension produced by the tensor palati muscle and thus permit mesial displacement of the palatine insertion of the superior constrictor muscle of the pharynx (Fig 12). The function of the tensor

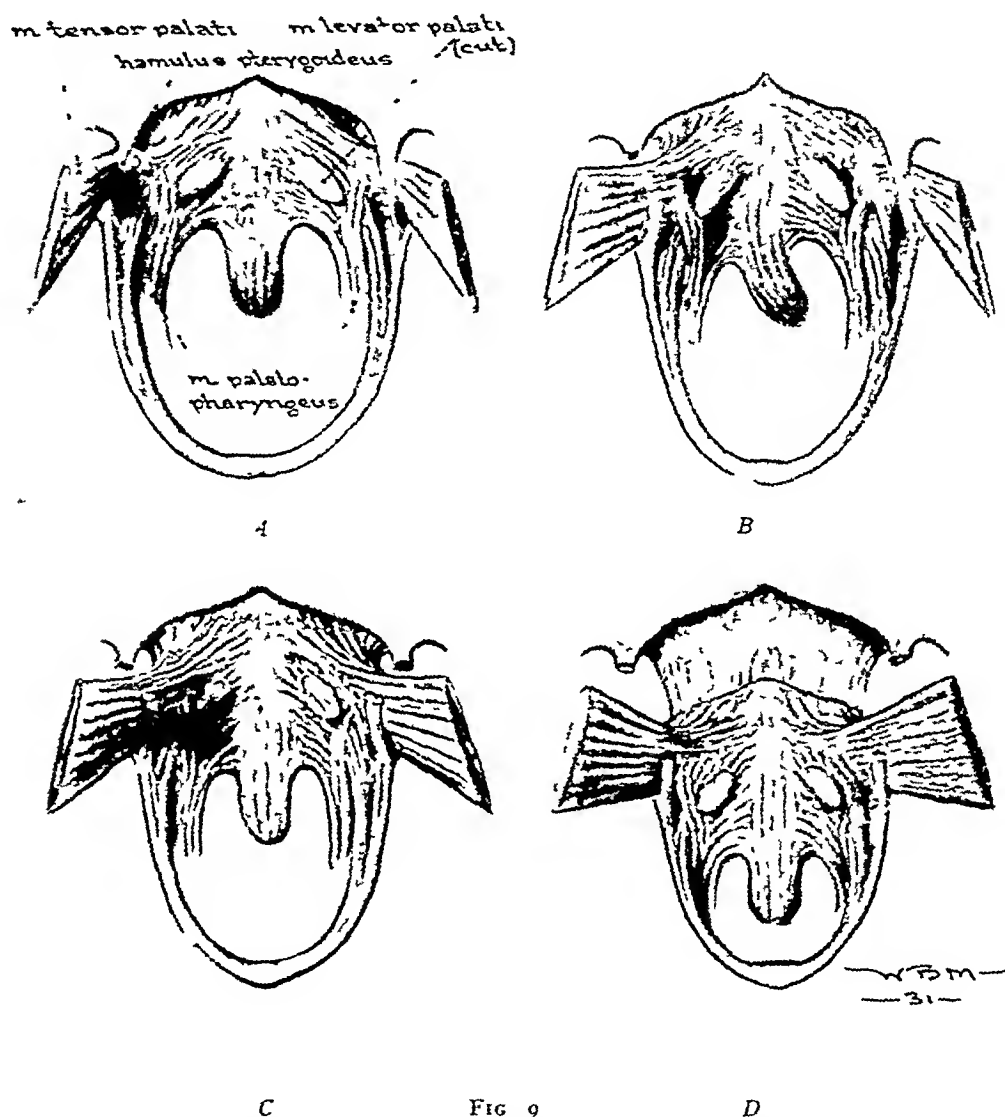


FIG 9

FIG 9A—Dissection of pharynx in a congenitally short palate. B—Division of one hamular process removes tension of tensor palati muscle. C—Note how division of both hamular processes removes all tension of tensor palati muscles and places palatine insertion of superior constrictor in desired position to close the nasopharynx. D—Backward displacement of the palate with division of hamular processes restores "palato-pharyngeal sphincter" in cases afflicted with congenital shortening of the palate.

palati muscle will also be altered from that of a tensor to that of an elevator and render it an assistant to the levator palati muscle. By this means lateral tension is removed and the anterior ends of the cleft pharyngeal ring in split palate can be approximated at the mid-line thereby restituting the divided velopharyngeal sphincter.

It is interesting to mention here that this lateral tension met with in cleft



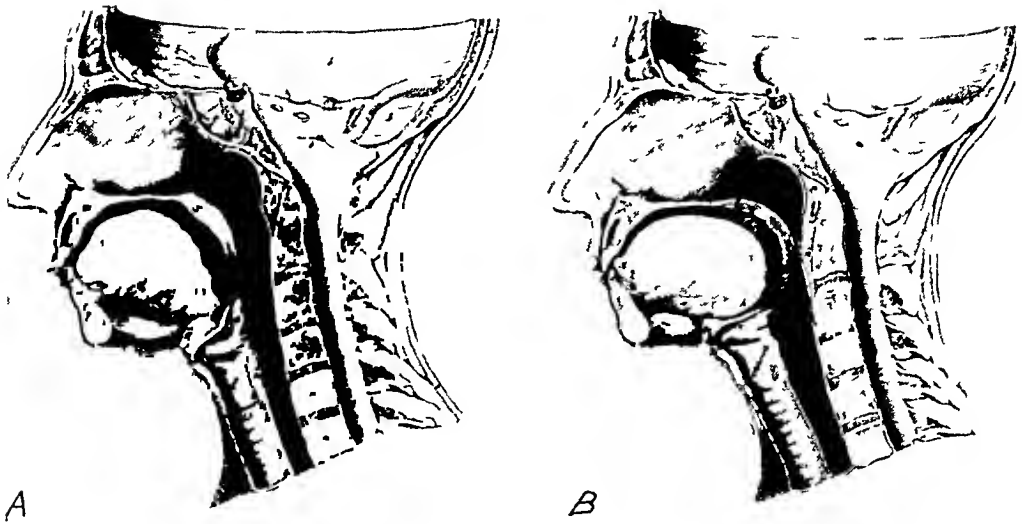


FIG 10—Sandfort's illustrations published in 1805. *A* shows the nasopharynx open. *B* shows the "palatopharyngeal sphincter" closed. Note the bulging forward of Passavant's cushion formed by contraction of the pterygopharyngeous portion of the superior constrictor muscle of the pharynx. Taken from Sandfort's "Deglutitionis Mechanismus, Verticalis Sectione Narium, Oris, faucium, Illustratus."

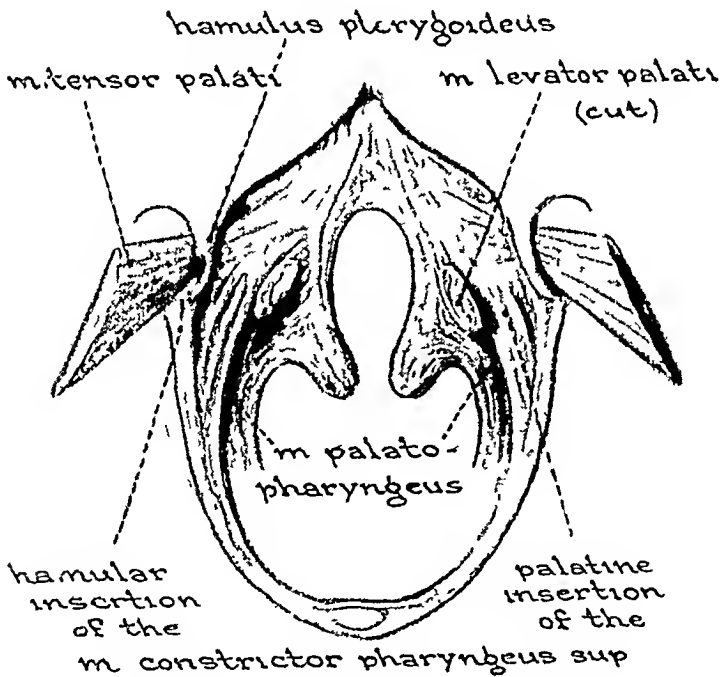


FIG 11—Dissection of the cleft velum in a child about two years old to show the split pharyngeal ring. Note the palatine insertion of the superior constrictor muscle of the pharynx. Each half of the split velum is shortened by outward and forward pull of the tensor palati muscle.

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palate was observed by the early pioneers of cleft-palate surgery Malgaigne attributed it to a "muscular action which is not easily accounted for" Sir William Fergusson held the same view However, the lateral and forward pull of this muscle was recognized as early as 1846 by Liston, who emphasized the necessity of dividing the tendon of the tensor palati muscle to

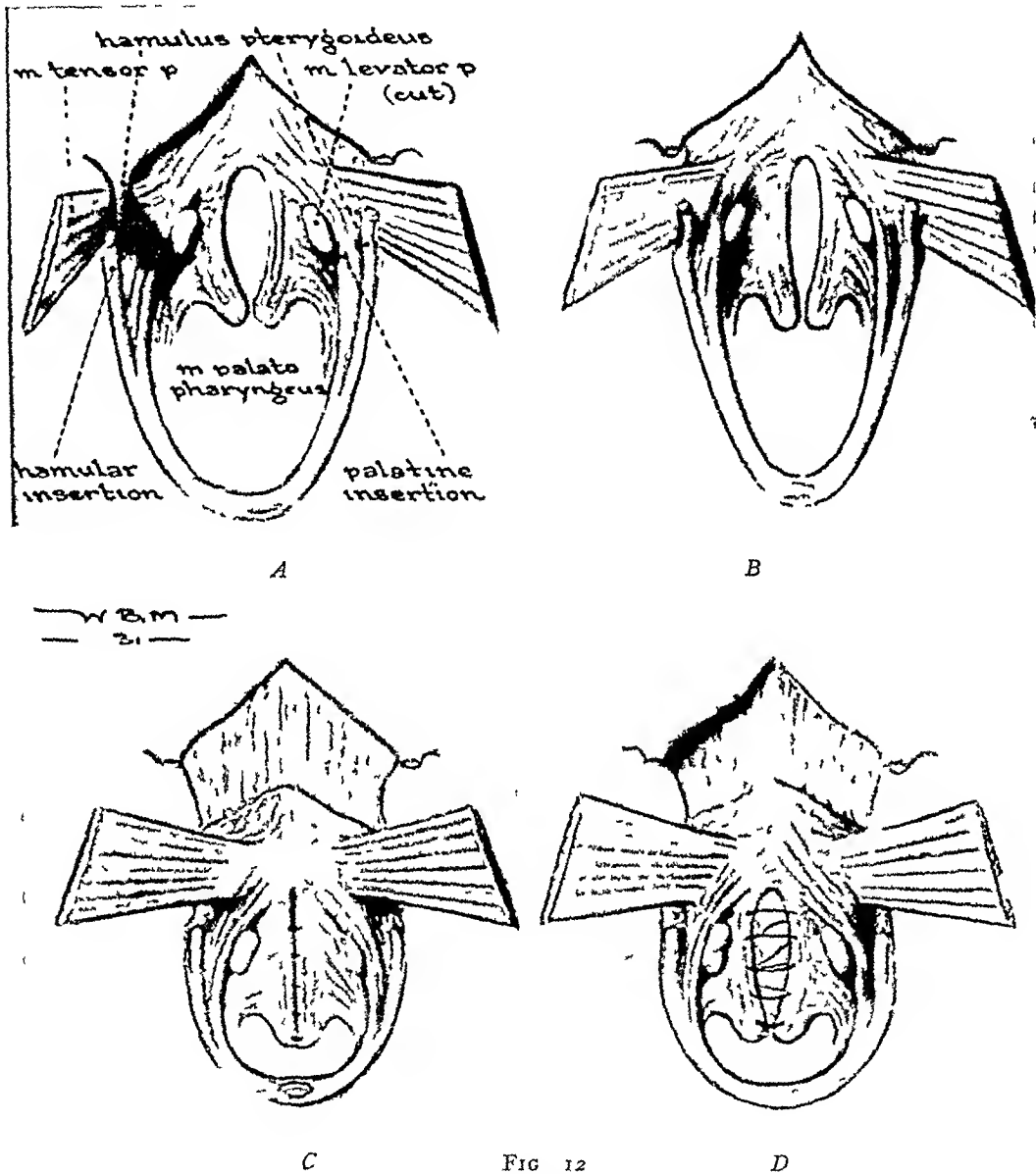


FIG 12 A—Division of hamulus on one side removes tension of tensor palati muscle B—Division of hamulus on both sides removes tension of tensor palati muscles C—Note how backward displacement of palate with division of hamular processes restores "palato pharyngeal" in cases afflicted with split velum D—Note how the "palato pharyngeal" is restored when the sutures are applied in the "push back operation" performed in cases with split velum

insure success This idea was subscribed to by Skey, in 1851, and Pollock, in 1856, who divided the muscle proper Agnew, in 1860, Warren, in 1863, and Schuh, in 1863, advocated section of the tendon of this muscle In 1868, Whitehead advised division of the hamular process and the muscle In 1889, Billroth suggested breaking off the mesial pterygoid plate in order to release the lateral pull of the tensor palati muscle

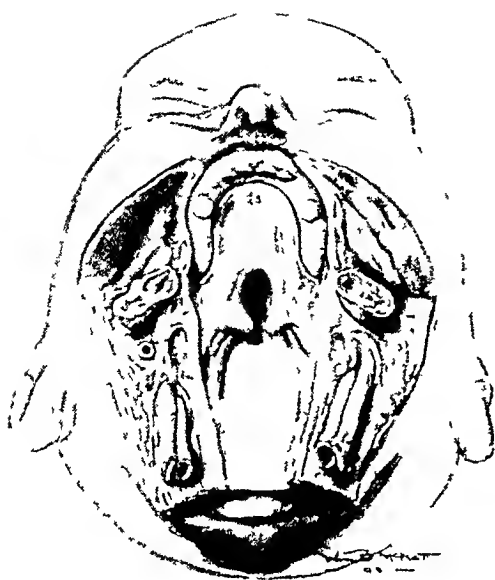


FIG 13

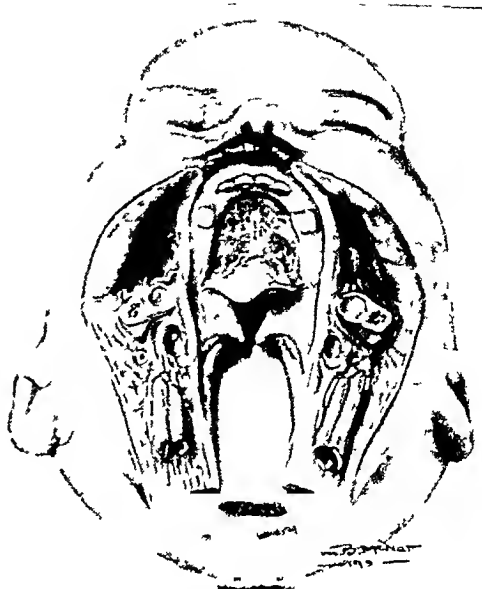


FIG 14

FIG 13—Shows the relaxation incision applied in the first stage of the "push back operation"  
 FIG 14—Shows how the palatine mucoperiosteum is raised from the underlying bone all the way back to the attachment of the palatine aponeurosis



FIG 15—Shows the end of the first stage in a "push back operation" performed for a cleft velum. The raised palatine mucoperiosteum is held in position with silk sutures

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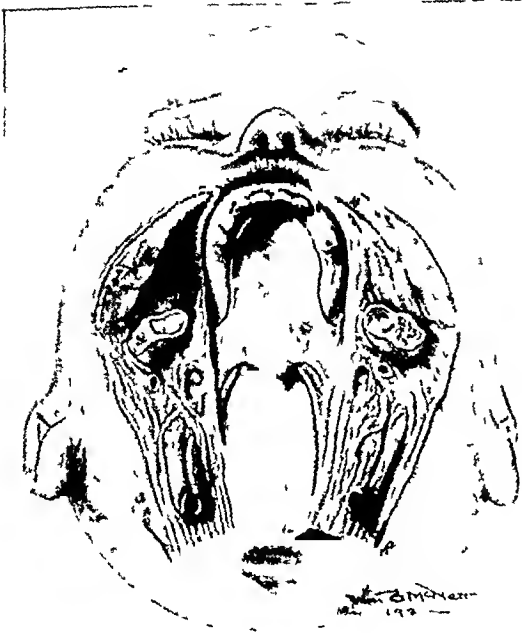


FIG 16

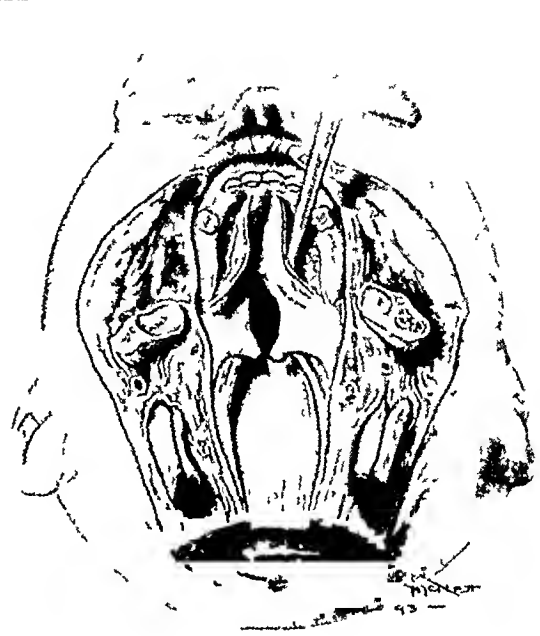


FIG 17

FIG 16—Depicts the lateral incisions applied in cases in which the palate has no adequate blood supply. Note the anterior bridge of attachment for nourishing the flap until collateral circulation is established.

FIG 17—Shows how the palatine mucoperiosteum is elevated when lateral incisions are applied.

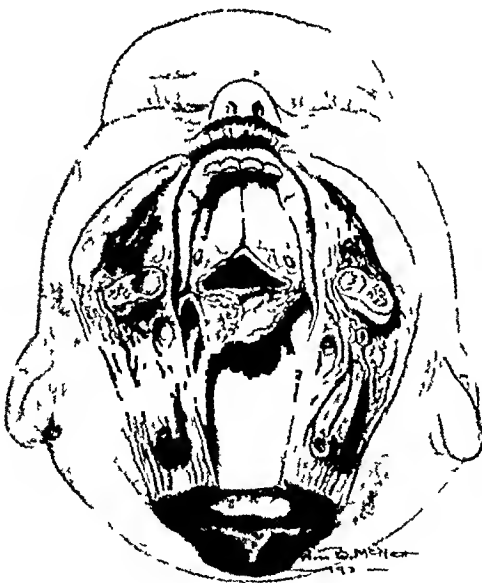


FIG 18

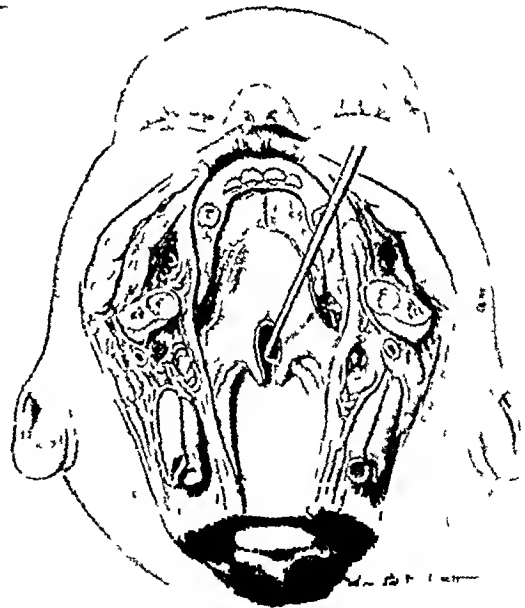


FIG 19

FIG 18—Shows the second stage of the "push back operation." The palatal mucoperiosteum has been completely freed from the underlying bone and the nasal mucosa divided from its connection with the posterior border of the hard palate. The hamular process is also sectioned above its connection with the mesial pterygoid plate.

FIG 19—Shows the displaced palate completely freed. Note how the ends of the relaxation incision are extended over the pterygomandibular fold. The borders of the cleft velum are also freshened.

The *raison d'être* of our method of operating for cleft palate is to restore the velum and place it in a normal or in an approximately normal position so that the resultant velopharyngeal closure will adequately shut off the nasopharynx and enable the patient to speak distinctly. With this object in view, we usually perform a two-stage operation. In the first of these proceedings the necessary relaxation incision (Fig 13) is applied so as to raise the pala-

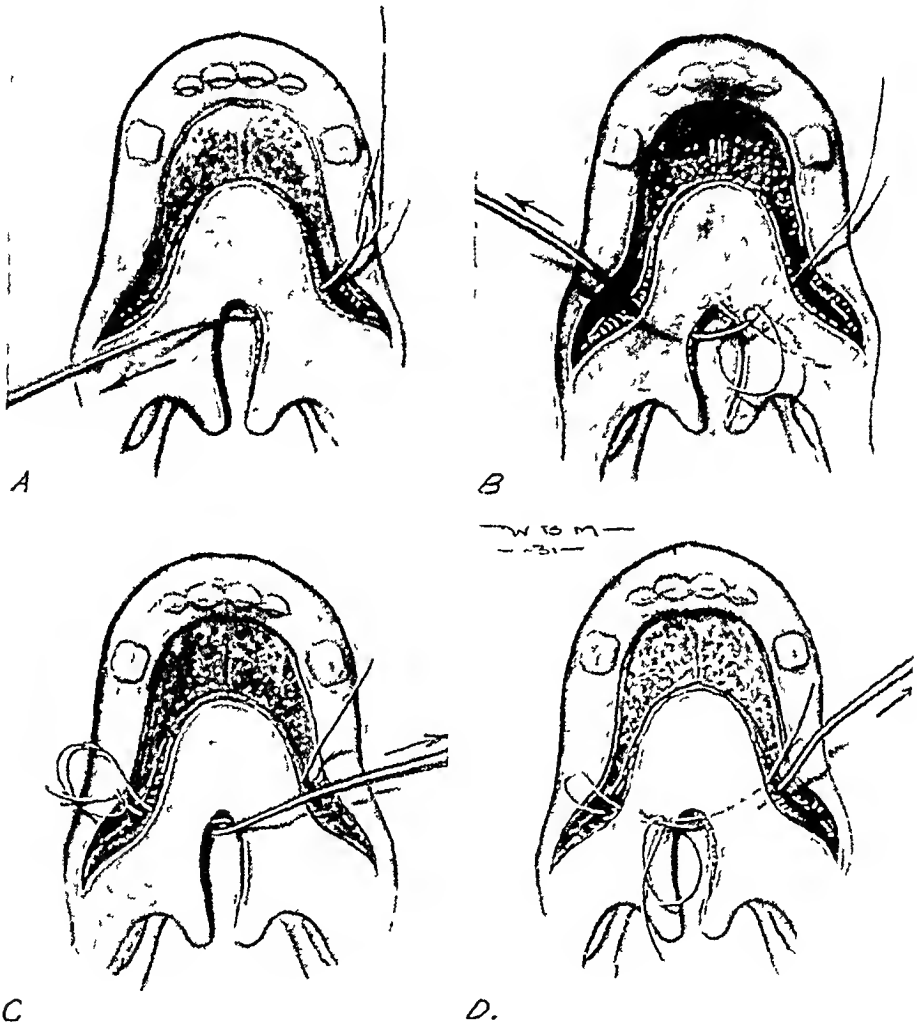


FIG 20—Depict the placing of the aluminum bronze suture through the muscle tissues. This suture was first used by Dr Victor Veau

time mucoperiosteum from before backward by dissecting it from the underlying bone with suitable elevators (Fig 14)

The posterior palatine arteries are divided as the palatine mucoperiosteum is freed from its bed all the way back to the attachment of the palatine aponeurosis. When this is completed, the flap is replaced in its original position and held with sutures (Fig 15). At times, especially in cases in which the palatal tissue is delicate, a lateral incision is applied on each side, leaving for the flap an anterior bridge of connection behind the incisor teeth (Figs 16 and 17). This bridge is divided in the second stage of the operation. From three to six weeks later, when the collateral circulation is established,

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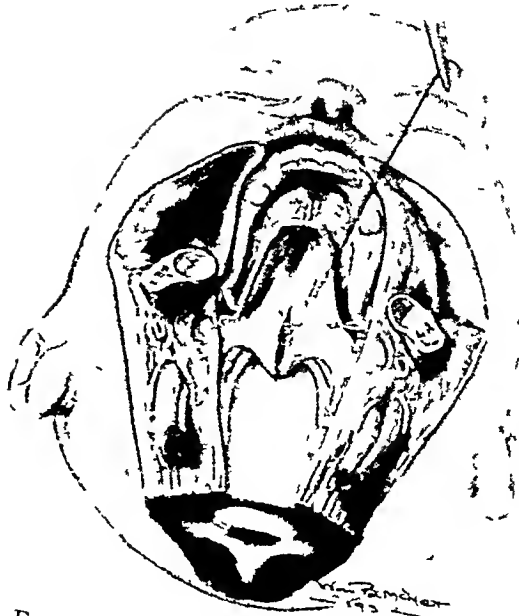


FIG 21—Show the intramuscular wire suture in place and the silk coaptation sutures in the nasal mucous membrane

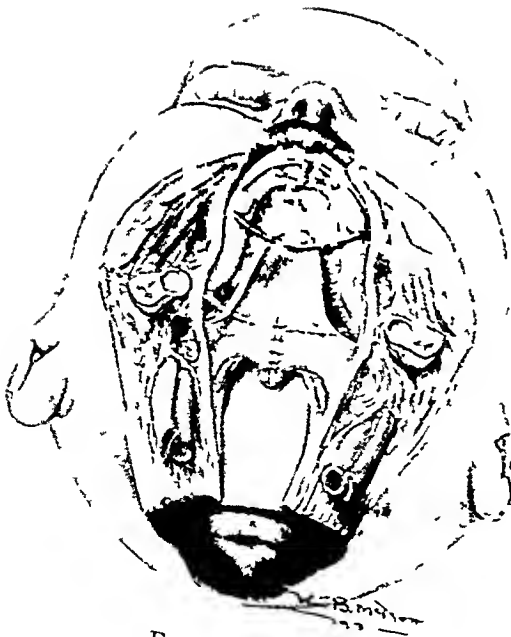


FIG 22

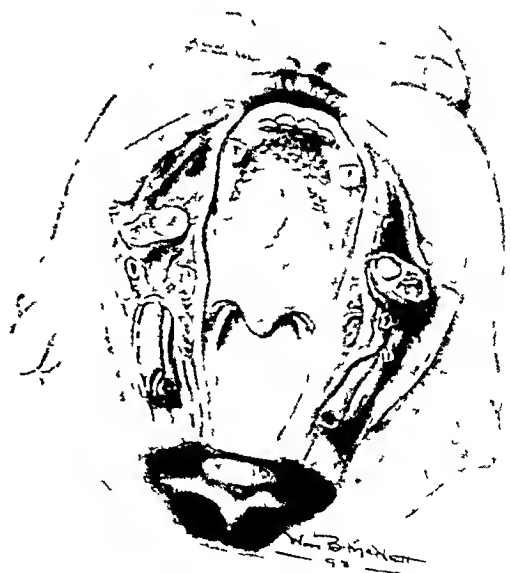


FIG 23

FIG 22—The cleft palate completely closed at the end of the "push back operation" Note the wire support applied across the palate and around the maxillary teeth to hold the displaced palate upward against the bone

FIG 23—The healed palate after the "push back operation" Note that the denuded bone has completely filled with granulation tissue The cleft anterior segment of the pharyngeal ring has been restored, thereby restituting the split "palato pharyngeal sphincter"

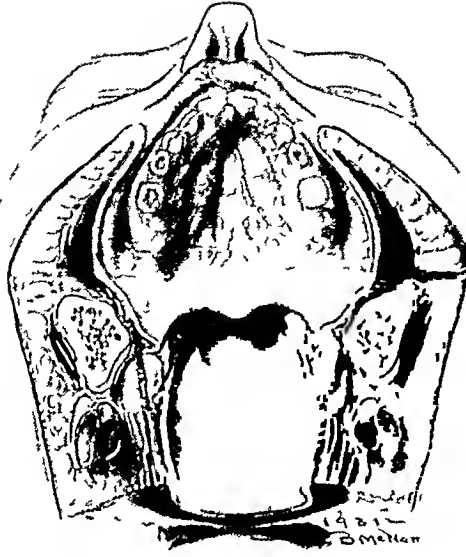


FIG 24

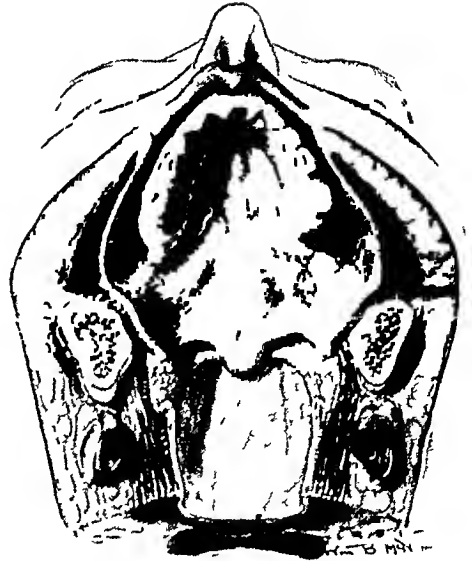


FIG 25

FIG 24—An adult female patient with submucous cleft palate. Note extensive absence of bone from the median palatine region. The palatine mucous membrane is intact. The "palato-pharyngeal sphincter" is too wide to close the nasopharynx. The anterior segment of this sphincter is also cleft due to a submucous cleft in the muscle tissue.

FIG 25—The same adult female patient with submucous cleft palate after the "push back operation." Note how the palate lengthened thereby narrowing the nasopharynx. The palato-pharyngeal sphincter can now function properly.

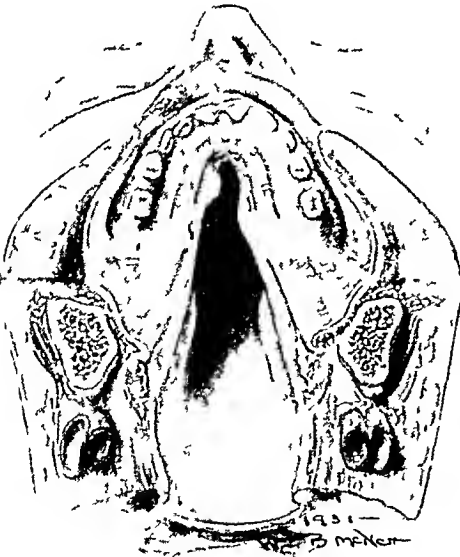


FIG 26

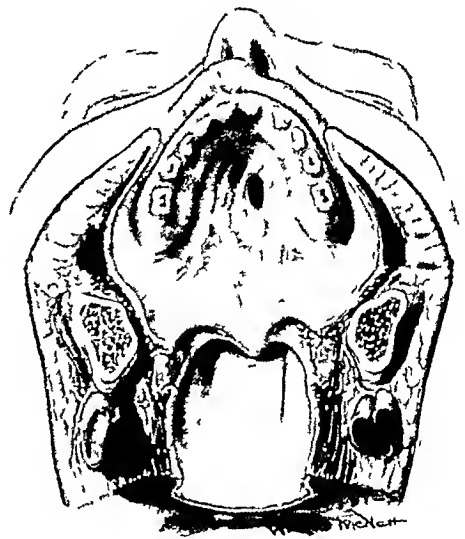


FIG 27

FIG 26—View of the palate of an adult female as she came to our clinic seeking treatment. This patient was operated upon previously with failure. Note how the velum is lost into the lateral walls of the pharynx due to previous operative interference.

FIG 27—The same patient after the "push back operation." Note the way the palate has been lengthened thereby enabling the palato-pharyngeal sphincter to close the nasopharynx. The holes in the anterior portion of the hard palate will close after cauterization. If these holes persist they can easily be covered with a plate made of vulcanite.

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a condition determined by the color of the flap, the final procedure is instituted. The mucoperiosteum is again elevated and the palatine aponeurosis and nasal mucous membrane freed from their connection with the posterior border of the hard palate (Fig 18). The hamular process is divided by means of a chisel on either side above its attachment to the mesial pterygoid plate. In all cases, it is necessary to extend the relaxation incision backward around the tuberosity and over the pterygomandibular fold to obtain sufficient mesial displacement of the muscular tissue (Fig 19).

When the tension is freed, the two halves of the cleft meet easily in the mid-line, the velum will be in contact with the pharyngeal wall and when the sutures are subsequently applied, the pharyngeal sphincter will be restored.

The next step is to freshen the borders of the cleft and insert interrupted sutures in the nasal mucous membrane, the ends of these sutures are left long and are not tied until the insertion of the intramuscular wire suture which was first suggested by Dr Victor Veau.

An aluminum-bronze suture is placed into the muscles—this we accomplish as follows. A Reverdin needle is introduced into the muscular tissue through the right relaxation incision (A Fig 20) and gently pushed through until it emerges at the mid-line of the right flap. The wire is passed through the eye of the needle and is dragged through the muscle by withdrawing the needle until one inch or more emerges at the right relaxation incision. The needle is now inserted into the muscular tissue through the left relaxation incision at a point opposite the place of exit of the wire from the previous step (B Fig 20). As the point of the needle is seen in the cleft the end of the wire suture is picked up and drawn through the muscle. When the needle is withdrawn, the wire suture emerges at the left relaxation incision. The needle is now inserted in the mesial portion of the left flap about one quarter of an inch below the wire which lies across the mid-line and pushed intramuscularly through the left flap so as to emerge again in the left relaxation incision (C Fig 20). The wire is passed through the eye of the needle, which is now withdrawn. The needle is again inserted in the right relaxation incision and pushed intramuscularly through the right flap towards the mid-line where the end of the wire is picked up in order to withdraw it to the right relaxation incision (D Fig 20). A study of the diagram will show the placing of the wire suture and will make the procedure much more easily understood.

The interrupted sutures placed in the nasal mucous membrane are now tied (Fig 21). The two ends of the wire suture, passed through the muscular tissue, are twisted together to bring the flaps in apposition at the mid-line. The oral mucous membrane is united with coaptation sutures (Fig 22). The anterior extremity of the displaced palate is held against the denuded palatine vault with sutures passed through the bone. A further support is obtained by passing a heavy piece of silver wire behind the premolar or one of the molar teeth, then across the palate and behind the same teeth of the opposite side using wire of sufficient length so that the two ends can be molded around the dental arch meeting in front of the incisor teeth where the ends are twisted together and turned back over the incisors. An iodoform gauze pack is then placed between the wire splint and the united palate so as to support it. This gauze pack is changed after four days. The denuded bone and gaps formed at the site of the relaxation incision close with granulation tissue (Fig 23).

In dealing with cases of lip-jaw-palate splits, in which the soft tissue is of adequate length, a modified von Langenbeck procedure is performed. In brief—this modification consists of releasing the tension produced by the tensor palati muscles and extending the relaxation incision over the pterygomandibular fold, the application of the muscle suture and the use of the two-stage procedure whenever we find that the palate has not an adequate blood supply.



The "push-back operation" is used in cases with congenital shortening of the palate, cleft velum and cleft palate which extends as far forward as the anterior palatine foramen. In these cases, the operation ends with complete restoration of the palate. It is likewise applicable in cases of complete cleft palate in which the velum is short and the von Langenbeck operation cannot insure success. Here there occurs a defect in the anterior portion of the hard palate for which we advise an obturator-plate to which may be attached all the teeth missing from the upper jaw. We have found the "push-back operation" invaluable in reclaiming the palates of individuals in whom the usual cleft-palate operation has ended with operative and functional failure.

The age of choice for cleft-palate operations is always a matter for discussion. It is our opinion, as to this point, each case of cleft palate is a law unto itself, the decision as to the proper time to operate being influenced by such factors as the general health of the child, the type and extent of the deformity and the character of the tissue. When conditions are favorable, we usually operate between the second and fifth year. In our experience, operations performed after the fourth year are free from mortality and the failures are less frequent.

From a study of our follow-up of cases of cleft palate and the cases that came to our clinic after having been operated upon by other surgeons, we are convinced that where no shortening of the velum exists good operative and functional results may be obtained in the hands of skilful operators by any of the classical cleft-palate operations.

From the patient's standpoint, any operation on the palate is judged by the functional speech obtained following operative interference regardless of the opinion of the operator.

Speech training will do much towards improving the patient's speech habits, but in a broad general way the more satisfactorily the palate is restored to establish a proper velopharyngeal sphincter the less necessity there will be for speech training.

Figs 24 and 25 show a case of congenital shortening of the palate before and after the performance of the "push-back operation", while Figs 26 and 27 present a case of cleft palate which has been satisfactorily closed by the "push-back operation". The patient whose palate is depicted in Figs 26 and 27 was previously operated upon before coming to our clinic by the von Langenbeck operation which terminated with failure.

# THE PRE-OPERATIVE AND POST-OPERATIVE CARE OF CONGENITAL CLEFTS OF THE LIP AND PALATE

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THE pre-operative and the post-operative care of patients with congenital clefts of the lip and palate is of considerable importance. The age of the patient and the location of the field of operation materially increase the operative risk. The mortality rate in children under two years of age has been frequently emphasized and every precaution which can be taken to lower this rate is well worth the trouble. I feel that this can best be accomplished by suitable pre-operative preparation, skillful operative work, and well-directed post-operative care.

For several years it has been my privilege to have a good deal to do with the cases of congenital clefts of the lip and palate in the service of Dr. John Staige Davis, at the Union Memorial Hospital. Inasmuch as the methods he uses in the pre-operative and post-operative care have been very satisfactory both in his cases and in my own, it occurred to me that an outline of the routine used in preparing these patients for operation and in caring for them after operation might be useful and interesting.

No surgeon should undertake the repair of congenital clefts of the lip and palate who has not had sufficient special training to assure a fairly rapid and skillful piece of work. After seeing the results of failures in other clinics I feel strongly that no one is justified in doing what may become irreparable damage to the patient because he is not thoroughly familiar with the necessary procedure. The repair of the lip or of the palate should not take much over an hour in ordinary cases.

There is still some difference of opinion as to the best time to correct these defects. We are convinced that the cleft lip should be repaired as soon after birth as is possible, depending upon the nutrition and the vitality of the child. The general condition of the patient is of prime importance and one should not be rushed into operating because the "new-born are immune to shock," or because "no mother should see her baby with a cleft lip." The closure of the lip can be delayed until some time before the end of the third month, or even longer if necessary, the most favorable time being within the first six weeks.

We have found that the best time for the repair of the cleft palate is between eighteen months and two years. The tissues have developed sufficiently by that time to be easily handled and will hold sutures without tearing. The earlier closure of an accompanying cleft of the lip will usually bring the margins of the alveolar cleft close together and will probably definitely narrow the palate cleft. The closure of the palate should not be

delayed longer than two years, unless absolutely necessary, because the time for speech development has arrived and the patient should be spared the difficulties of relearning to articulate

We feel that the pre-operative and the post-operative care determine to a very great extent the percentage of success and failure and probably have also much to do with the mortality. The cause of death is usually bronchopneumonia or gastroenteritis, and occasionally a child will die upon the operating table from the anæsthetic. In a large series of cases under two years of age Doctor Davis has had one death which occurred upon the operating table from ether anæsthesia. More than half of these cases were operated upon twice before they were two years of age—once in the early months for the lip, and later for the repair of the palate. Reports in the literature give a mortality rate ranging from 1 to 8 per cent<sup>1</sup> on patients under two years of age.

I shall consider the pre-operative care of the patients to be operated upon for cleft lips and cleft palates separately as they present somewhat different problems.

If the patient with a cleft lip is in poor condition we advise admission to the hospital as soon after birth as possible. No date is set for the operation and the family is told that it will be performed as soon as the baby is fit. However, if there is an attending pediatrician, the child is left in his care until he is sure that operation can be safely risked, which is usually about the time when normal birth weight is reached. Then the patient is admitted, preferably forty-eight hours before operation.

The dietetics of these little patients is always a problem which must be solved before any operative treatment is attempted. Because of the inability to suckle they are usually fed with a spoon or medicine dropper and a great deal of air is swallowed with the feedings, which tends to insufficient nourishment. They often fail to do well if fed on improper formulas and gastrointestinal disturbances frequently follow which may be difficult to correct. However, if a satisfactory formula is developed by the outside pediatrician, we follow it after the child is admitted at least well on into the convalescence.

The feedings of the patients admitted to the hospital are worked out by the pediatrician in charge, under whose dietetic care they remain until discharged from the hospital. Feedings are given by means of glass syringes with large openings in the nozzles to permit the free flow of milk and also to permit the feeding of concentrated foods if necessary. The syringes used are similar to the ordinary Dakin's syringes with blunt points. If a sharp-pointed syringe is used the nozzle is capped with a piece of rubber tubing to prevent accidents. After each feeding the mouth is carefully cleansed with boric solution. Because this method has been entirely satisfactory we have not used any of the complicated dams or other apparatus devised for feeding children with cleft lips. No operative work is done until the patient is gaining weight satisfactorily, excepting in an occasional case when, despite every effort, the patient fails to thrive. In these cases an operation must be

## CLEFTS OF LIPS AND PALATE

risked after the pediatrician has assured himself that the trouble lies in the gastro-intestinal tract and that further delay might be dangerous. These children frequently will begin to improve as soon as the lip is closed.

In addition to milk, patients are given orange juice with cane sugar twice daily and sodium bicarbonate in proper dosage three times daily as this tends to lessen the possibility of acidosis after operation.

In the meantime the patient is given a careful physical examination. Special history sheets<sup>2 3</sup> are used for recording the history and the physical examination. The house officer in charge fills in answers to all the questions on the sheet and marks in with red ink the type of cleft of the lip, or palate, or both, upon the marginal diagrams. This method makes the histories valuable for future study since fairly complete data are thus secured in every case.

The Wassermann reaction, hæmoglobin, bleeding time and clotting time of the blood are secured. We do not operate if the hæmoglobin is below 70 per cent and prefer to have it above 80 per cent if possible. The bleeding time and the clotting time should be normal. If these are prolonged, calcium lactate is given in doses appropriate to the age of the patient. If jaundice is present the operation is delayed until it clears up, everything else being satisfactory.

The patient is given daily exposures under the violet-ray lamp beginning with one minute, the patient being thirty inches from the light, and the time being increased one minute daily until the daily exposure is five minutes. The eyes are protected by dark goggles and the entire body is exposed. The reaction of the patient is watched and the exposures decreased in time or frequency if necessary. We feel that this treatment probably has a beneficial effect upon the hæmoglobin.

Transfusions of whole blood are given when the condition of a patient is very poor or if the hæmoglobin fails to respond to ordinary treatment.

If syphilis is found, which is quite rare in our experience, operation is deferred until treatment has been started and the treatments are continued after operation as long as necessary.

There is a pronounced tendency to respiratory diseases in congenital clefts of the lip and palate because of the intruding of air which has not been warmed and cleansed by a normal passage through the nose and because of the inhaling of fluids while feeding. Some surgeons feel that these patients should not be operated upon during the fall and winter months when the air is cold and respiratory diseases most prevalent. However, if the patient is hospitalized in a protected cubicle for a sufficient time before operation this objection is minimized and we do not hesitate to operate at any time of the year after adequate preparation. Two drops of 20 per cent argyrol are put into each nostril three times daily while the patient is waiting for operation. No patient is operated upon who has any rise in temperature for forty-eight hours before operation.

The presence of an enlarged thymus gland is frequently stressed as an important factor in the mortality rate. Some surgeons have their patients

routinely X-rayed to determine the condition of the thymus gland before operating. If the thymus is enlarged X-ray treatments are given until its size is reduced. One or two exposures have only a passing effect upon the gland and numerous exposures have a tendency to cause fibrosis of the lungs, which may possibly result in pulmonary ailments later in life. We have not given the presence of an enlarged thymus gland found on physical examination any special consideration and do not have routine X-rays taken. We have had, as yet, no untoward results and feel that the danger can be minimized by skillfully given anæsthesia.

The urine is examined for albumen, sugar, acetone, pus and casts. Any abnormal condition found is treated.

The preparation of the patient takes from a few days to several weeks, depending upon the condition on admission. After the child has become acclimated and adjusted to the routine of the nursery and has been taught to take its food through a syringe, the preparation is complete if all other conditions are favorable. This preparation is well worth while as a very young child can hardly be expected to survive if it has a serious operation added to dietetic or respiratory troubles which have sapped the little vitality it possessed.

The pre-operative care of a patient for a cleft palate operation is slightly different because the patient is older. As mentioned previously, we feel that the best time for repairing congenital clefts of the palate is between eighteen months and two years. In many instances, the patient has been under our care before when the cleft lip was repaired and the parents were instructed concerning feedings when the patient left the hospital. Upon readmission the parents are questioned concerning the diet of the patient and the gain in weight. If the pediatrician feels that the child has done well no attempt is made to change the type of feeding before operation, even though it may not be scientifically suitable for a child of that age. An immediate change of diet in these cases would cause unnecessary delay since it would be unwise to operate until the patient had been found to be gaining weight upon the new diet. In the ward the child is given orange juice with cane sugar twice daily and sodium bicarbonate three times daily in doses appropriate to its age. Two drops of 20 per cent argyrol are put into each nostril three times daily.

The blood and urine are examined as described above. If the hæmoglobin is found to be low, the patient is given cod-liver oil and syrup of the iodide of iron in addition to violet rays.

The past history of these patients is investigated to ascertain whether there has been any exanthematous disease, respiratory disease, or ear infections. There should be an interval of three months between the last disease and the operation. If the examination of the throat reveals infected tonsils and adenoids a tonsillectomy and adenoidectomy are done and in a few days the patient sent home for at least three and preferably six months. The presence of infected tonsils and adenoids militates against

primary healing and one is not justified in taking a chance where tissues are so scant and secondary repairs extremely difficult. The interval of time permits the area to heal well and the scars to soften so that the soft palate can be more easily repaired.

Parents are instructed to have all decayed teeth taken care of by a dentist before bringing the child for operation. These precautions are taken to remove any foci of infection from the mouth which might jeopardize healing.

The average uncomplicated case is operated upon within forty-eight hours after admission to the hospital. However, if anything abnormal is found, the operation is delayed until such time as the pediatrician feels that the child is a good risk.

Food is given both lip and palate patients until eight hours before operation and water is given until they are sent to the operating room. No drugs or sedatives are given pre-operatively to the children under two years of age. Atropin is sometimes given older children and frequently avertin is used in small doses to eliminate the fear and anxiety caused by the preparation for operation and the initial anæsthesia. The children are brought to the anæsthetizing room in their own beds. Ether is given by the drop method until the patient is in the secondary stage, at which time he is wheeled into the operating room. The anæsthetist should always be experienced as these anæsthesias are difficult. The anæsthetic is usually given through a spray or through the attachment on the tongue depressor of a S. G. Davis mouth gag.

The patient is secured upon the operating table in such a manner that the head can be lowered into the lap of the operator. We feel that this position gives the operator the best view of the operative field and makes the aspiration of blood and mucus into the lungs less likely. We try at all times to keep the anæsthesia so light that the reflexes are not lost. An assistant keeps the throat clear of blood and mucus by means of a suction apparatus. The entire time of anæsthesia is usually kept below one hour and a quarter and the operative time is usually about one hour.

After the operation on the lip is finished the skin is wiped clean and the suture line is painted with third strength iodine and over this evaporated compound tincture of benzoin is applied. The iodine is one third of the standard pharmaceutical strength and the benzoin has been evaporated to the consistency of thin molasses. No other dressings or appliances are used in the lip cases. After the palate operations the suture line and the lateral incisions are painted with 20 per cent argyrol which is also dropped into the nostrils. All bleeding should be checked as carefully as possible before the patient leaves the operating room. Iodoform gauze packs are placed in the lateral relaxation incisions after the palate operations if there is any oozing. No apparatus or plates of any kind are used to support the stitches in these cases as we feel that they are hard to keep clean and are a hindrance to good healing. A small split rubber tube is placed in the nostril on the operated side after the lip has been repaired to aid the patient in breathing and to help to shape the nostril. We consider that the light anæsthesia prevents

aspiration pneumonia and is well worth while even though it makes operating a little more difficult because the patient may move

The tissues of both the lip and palate are handled as gently as possible during the operation to avoid any unnecessary trauma. All lip and palate flaps are thoroughly mobilized. Dural hooks are used instead of thumb forceps whenever possible and clamps are never put on the margins of lip or palate flaps to stop bleeding or to act as retractors. The skin surface of the lip and the vermilion border are always closed with horsehair, silk being used in the mucus membrane. The palate flaps are closed entirely with horsehair sutures, which are easily kept clean, because mucus and milk do not adhere to them as to silk and so are a great advantage in the post-operative care. Horsehair also has the advantage of some elasticity which permits post-operative swelling of the sutured parts without causing necrosis at the points where the sutures are placed, thereby preparing an entry for infection. We feel that the stiff ends of the tied horsehair tend to keep the tongue away from the palate and are an advantage even though they may cause some temporary discomfort.

The patients are placed in their own beds, which have been carefully warmed, directly from the table in the operating room, thus eliminating unnecessary exposure and handling. Patients operated upon for cleft palates are placed upon their abdomens with the heads turned to one side, so that mucus or blood can easily run out of the corner of the mouth. A nurse is in constant attendance until consciousness returns so that no accidents may occur because of difficulty with breathing, especially after cleft-lip operations where the lower lip may act as a valve and prevent satisfactory interchange of air. Codeine sulphate is given hypodermically to patients operated upon for cleft palates in sufficient amounts to keep them comfortable and quiet. Paregoric is given to patients operated upon for cleft lips. We try to prevent crying as much as possible.

The palate cases are not given anything by mouth for twenty-four hours after operation. The cleft lip cases are given sterile water as soon as they can swallow and sterile feedings are resumed four hours after operation.

All cases are given proctoclysis every four hours until they are taking fluids satisfactorily by mouth. This is particularly necessary in the palate cases which are kept from any fluids by mouth for the first twenty-four hours after operation. The solution used is made up of one gram of sodium bicarbonate and one cubic centimetre of commercial glucose to fifty cubic centimetres of water. A child of two months receives fifty cubic centimetres per dose and the dosage is increased according to the age or decreased according to the patient's ability to retain it. The proctoclysis tends to prevent acidosis and supplies necessary fluids.

Palate cases are given sterile fluids by mouth after the first twenty-four hours. The suture line is carefully cleansed with boric solution after each feeding and swabbed gently with 20 per cent argyrol solution. Two drops of 20 per cent argyrol are dropped into each nostril three times daily. In

## CLEFTS OF LIPS AND PALATE

the cleft lip cases the mouth is kept clean with boric solution and the suture line under the lip is painted with 20 per cent argyrol after each feeding

The patients are restrained by means of cuffs placed over the elbows. These are made of cardboard covered with muslin and prevent the children from touching their lips and mouths. The legs are restrained by means of loose muslin cuffs on restraining straps fastened to the beds. These permit the children to lie comfortably but prevent them from rolling upon their faces. After the tenth day the palate cases are given a very soft diet of cooked cereals, soft-boiled eggs, custards, and so on.

The compound tincture of benzoin dressing on the lip is softened with boric ointment applied twice daily after the fourth day. The stitches in the skin surface and the vermilion border of the lip are gradually removed from the fifth to the eighth days after operation. The sutures in the mucous membrane of the under side of the lip are removed on the tenth to the thirteenth days after operation. The sutures in the palates are removed on the thirteenth and fourteenth days after operation. We very rarely find it necessary to anesthetize a patient to remove sutures from the palate or from the under side of the lip. Patience and a little care will suffice without doing any damage to the lip or palate.

When the patient is discharged from the hospital the parents are instructed to massage and stretch the repaired lip for a few minutes each day over a period of at least six months.

The scope of this paper does not include speech training which is a necessary further step in the after-care of many of the palate cases.

In this series of cases I have never seen the suture line in the lip break down or separate. In the palate cases none have broken down completely but in a few, where the flaps have been very thin, there has been partial separation of the suture line. Occasionally, infection will attack the edges of the palate flaps, causing a very narrow grayish slough along the margins which prevents healing. So far we have been unable to check this type of infection, which fortunately is rare. These post-operative palate defects can be closed by secondary operation not sooner than six months after the first operation.

The pre-operative building up of poor surgical risks and the post-operative care of cleft lip and palate patients require ceaseless vigilance and the most exacting and conscientious type of nursing. The care of these patients requires special training of the nurses, upon whom the result depends probably more than it does upon the surgeon. We are particularly fortunate in having head nurses in the Johnson ward of the Union Memorial Hospital who are interested in these cases and enthusiastically supervise the work of the undergraduate nurses.

### SUMMARY

(1) Operations for the repair of congenital clefts of the lip and palate, except in rare cases, should never be undertaken until the patients are in the best possible physical condition.



(2) The pre-operative and post-operative care of these patients should be in the hands of a pediatrician working with the surgeon

(3) The repair of congenital clefts of the lip and palate should be done only by surgeons with special training

(4) The success or failure of the operative work depends largely on the skill of the nursing staff in carrying out post-operative orders

(5) The mortality rate should be as low as 1 per cent, if at all necessary

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# TRANSTHORACIC, EXTRAPLEURAL THORACOTOMY \*

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DURING the World War, a great number of combined abdomino-thoracic wounds were encountered and it did not take long for Field or Evacuation Hospital surgeons to discover that, in a majority of transdiaphragmatic wounds, the abdominal lesion was best reached and treated via the thoracic route. This was especially true of wounds involving the liver, spleen, cardia and lesser curvature of the stomach, sometimes even the transverse colon. In civil surgery the best approach to the subdiaphragmatic region has been found to be via the thorax, but, with rare exceptions, the transpleural route is still adhered to, involving as it necessarily must do danger of pleuro-pulmonary infection. Perusal of the latest editions of many of our text-books on general surgery sustains this statement.

In vol. II of *Abdominal Operations*, Sir Berkely Moynihan, writing of operations on the liver, states that this organ may be reached through a posterior incision along the eighth or ninth ribs, the pleural cavity being either traversed or avoided, in the latter case the pleura is lifted upwards out of the way. In the treatment of hepatic abscess he also states that "If one or more ribs are to be resected in order to obtain access to the pus, the incision must be made so low down on the chest wall that the pleura is not likely to be opened. As a rule this is avoided by keeping within a limit of two inches from the costal margin. If, however, the abscess has reached a higher level, the pleural cavity will have to be opened."

Gask and Wilson advocate either the abdominal or transpleural route in the treatment of subphrenic abscesses. Ochsner, in *Surgical Diagnosis and Treatment*, has nothing to say on the subject. McGrath mentions an abdominal and transpleural route, but does not even suggest an extrapleural approach. Horsley advises resecting about two inches of the ninth or tenth rib over the region of the abscess and protecting the pleural cavity by suturing or packing with gauze held in position by a few catgut sutures. In vol. IV of the *Precis de Pathologie Chirurgicale*, Gosset and Petit-Dutaillis mention the extrapleural resection of Lannelongue, which is described as a chondroplastic or costo-chondroplastic incision by my associate Dr. P. J. Sarma. This consists in a slightly curved incision from the ensiform process to the anterior end of the bony portion of the tenth rib, passing parallel with the chondral arch, and about 1.5 to 2 centimetres below it. Between the rectus and external oblique muscles on the outer aspect and the internal oblique and transversalis on the inner aspect, the lower border of the costal arch is exposed and can be easily freed. The insertion of the seventh costal cartilage is divided at the sternum and similarly the eighth and ninth costal cartilages are divided just distal to the bony ends of their corresponding ribs, or, if necessary, the ribs themselves are divided just proximal to the costal cartilage attachment. The main objection to the Lannelongue incision—and it is a serious one—is that it destroys the origin of both the external oblique and transversalis muscles as well as the aponeurosis of the external

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oblique Other subpleural routes mentioned by Sarma are (a) A right-sided transverse lumbar incision, running parallel with the twelfth rib, which is either retracted upwards of subperiosteally excised, (b) the intercostal subpleural route in which an incision is made between the lower border of the right tenth rib and upper border of the eleventh, in the mid-axillary line This incision is below the pleura but gives a very inadequate exposure, (c) excision of parts of the tenth and eleventh ribs in the mid-axillary line, (d) excision of portions of the seventh and eighth ribs in the antero-lateral aspect of the chest wall, exposure of the pleura and its upward displacement At this level it is hard not to open the pleura during the necessary blunt dissection Romanis and Michener, in vol 11 of Science and Practice of Surgery, state that "A subphrenic abscess is best opened by removing a portion of the ninth or tenth rib in the mid-axillary line, and incising the diaphragm across the usually obliterated pleural space in the phrenicocostal angle, or, by performing the operation a little lower, the pleura may be avoided altogether and

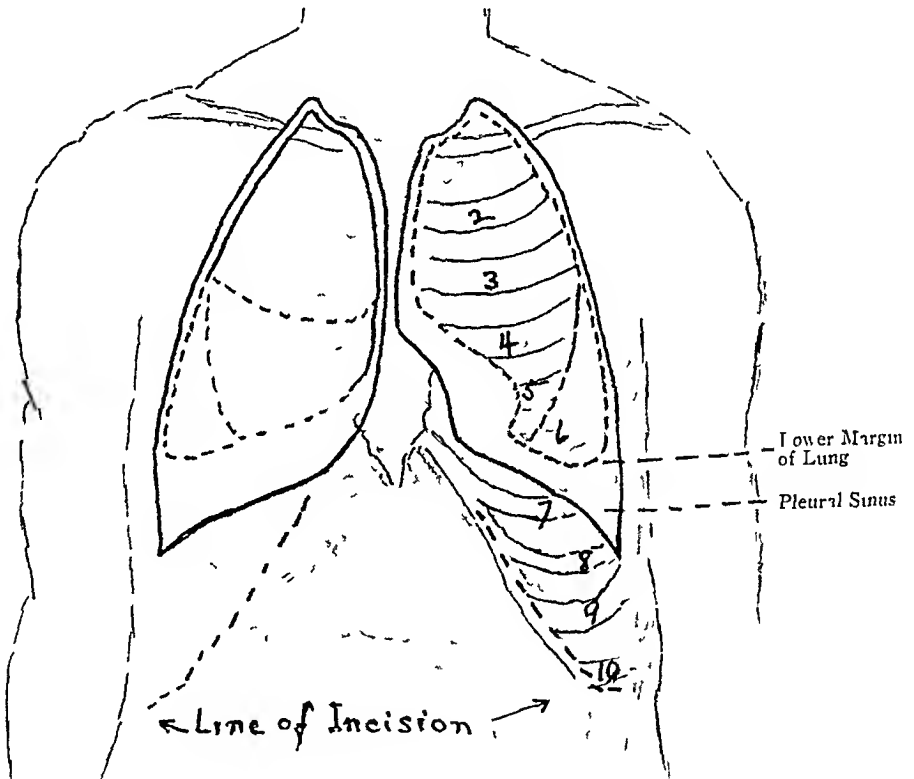


FIG 1 —Anatomic relationship of lung, pleura and incision

the diaphragm incised below it If the abscess is pointing at the abdominal wall it should be opened there, but a transpleural counter-opening is often necessary" Writing on the treatment of amœbic abscess of the liver, the same authors believe that probably the best approach is from the side, with removal of the ninth or tenth ribs, provided it is certain that the pleural cavity is already obliterated As it is a pre-operative impossibility to know what the condition of the pleural cavity is, this approach will, in a majority of cases, prove to be a transpleural one Rose and Carless, in their last edition, advocate draining a subphrenic abscess either through the anterior abdominal wall, with or without a counter-opening or through the pleural cavity They do add, however, that if the pleural cavity is not affected, the serous membrane covering the upper surface of the diaphragm must be stitched to the parietal pleura before the diaphragm is incised The same transpleural route is recommended for drainage of a hepatic abscess

## EXTRAPLEURAL THORACOTOMY

Binnie, in his *Operative Surgery*, states that "By the time that a hepatic abscess has become large enough to be diagnosed and its position ascertained, there is almost always adhesive pleuritis present, the liver is adherent to the diaphragm, and the diaphragmatic pleura to the parietal, so that a safe route exists to the pus via the obliterated portion of the pleural cavity. More cases of liver abscess can be reached through the abdomen than through the chest. The pus, in a subphrenic abscess, is reached in practically the same manner as is that in a hepatic abscess." Alton Ochsner has lately enlarged on the original technic of resection of the twelfth rib which he described with Nather in 1923. An incision is made over the twelfth rib to within 4 centimetres of the mid-line posteriorly and the entire rib is removed subperiosteally. The next step is a transverse incision of the musculature below the bed of the resected rib at the level of the first lumbar spinous process which should be marked before the operation. In this way the pleura will certainly be avoided. Careful dissection down to the renal fascia, which is recognized as a smooth, shining, fibrous layer, is now carried out. Beneath this fascia the renal fat can be seen. If a retrocæcal or retroperitoneal abscess is suspected, the skin incision can be extended downward and forward towards the anterior-superior iliac spine, the muscles split and the retrocæcal and retroperitoneal regions explored.

For abscesses situated higher up, Ochsner advocates a blunt separation of the peritoneum from the under surface of the diaphragm. He aspirates the pleural cavity above the diaphragm in those cases in which an empyæma is suspected, or explores the subhepatic space with a Clairmont curved aspirating needle. If an empyæma exists, he drains the pleura above the diaphragm. While probably quite satisfactory in the drainage of a retrocæcal abscess following appendectomy, the Ochsner exposure is too far away from the antero-lateral subphrenic region and unduly exposes the perinephric tissues to infection. It certainly should not be used as a means of approach to an amœbic abscess or ecchymococcus cyst of the liver and would be valueless in the treatment of any combined abdomino-thoracic wound.

That drainage of an abscess should be obtained without breaking through nature's defensive zone and, whenever anatomically possible, without traversing normal serous cavities is a surgical axiom. Even if the pus is often sterile, it may not be harmless. Moynihan tersely states that "no surgeon is entitled to assume that dirty work of any kind is harmless," and Ochsner correctly affirms that "drainage of any infected area through a non-infected wound or serous cavity violates all surgical principles. The drainage of a subphrenic pyogenic abscess through an uninvolved pleural or peritoneal cavity is as unsurgical as drainage of a pulmonary abscess through an uninvolved pleural cavity."

The objection to practically all of the forementioned incisions is that none of them is universally applicable as a means of access to the subphrenic region from the mid-line anteriorly to the vertebral column posteriorly. This is particularly true in the treatment of diaphragmatic prolapses, erroneously called diaphragmatic herniæ because almost all of them are devoid of peritoneal coverings. As recently as June, 1931, Bettman and Hess, reporting a successful repair of a diaphragmatic prolapse in a nine-months-old child, deliberately opened the pleural cavity. They erroneously state that "the child's pleura was filled with intestines." A diaphragmatic prolapse passes through a weakened portion of the diaphragm (through the left side in 122 cases out of 130 reported by Quenu and Féton), and pushes the pleura upwards without penetrating it. Only in the presence of strangulation will

serious agglutination, necrosis and perforation of the normally closed pleural sac occur. The pleura does not even entirely cover the superior surface of the diaphragm, from which it is readily separated.

Bettman describes the diaphragmatic approach as follows: "The incision started just posterior to the posterior axillary line and followed the ninth interspace to the costal margin and then swept upwards towards the left border of the sternum. Great care was taken to clean the parietal pleura in the ninth interspace so that the pleural cavity could be opened under direct inspection, lest the underlying bowel be injured. After the pleural cavity was opened, a ligature was passed about the ninth rib and another posterior to it. The rib was cut between. The ligatures were then tied so as to control bleeding and the incision into the pleura extended into the eighth interspace. The tenth rib was similarly dealt with. Rib spreaders were inserted and the pleural cavity inspected. A muscle-splitting incision was now made in the left hypochondrium and two fingers of the oper-

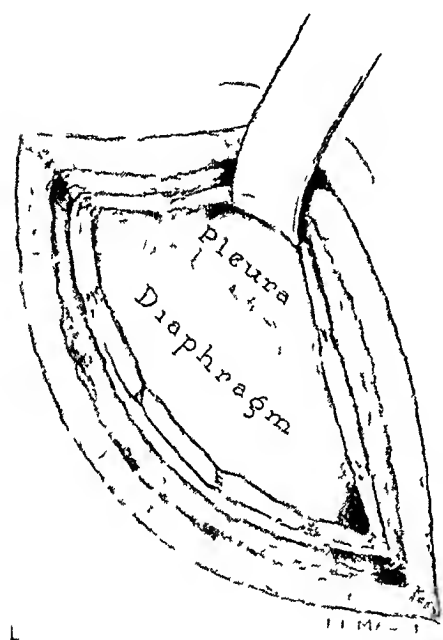


FIG 2—Chondroplastic incision exposing diaphragm and pleural sinus

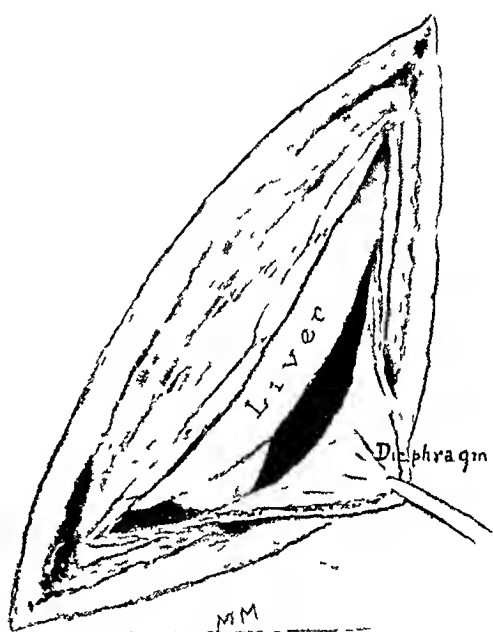


FIG 3—Diaphragm opened, liver exposed

ator's right hand introduced into the abdominal cavity up to the hernial opening." There is no argument regarding the advisability of a combined abdomino-thoracic approach in most cases of diaphragmatic prolapse, but the operation would have been greatly simplified had Bettman used the extrapleural approach to the diaphragm.

*Surgical Anatomy*—Before making any claims for a new surgical incision it becomes necessary to consider three important operative and post-operative factors, *i.e.* (1) Will the nerve supply of any of the important muscles or fasciæ involved in the incision be severed, will their main blood supply be jeopardized? (2) Will exposure be adequate and can dependent drainage be obtained? (3) Can firm closure be obtained?

The tissues involved receive their nerve supply from the antero-lateral branches of the seventh to twelfth intercostal nerves and from the ilio-hypogastric and ilio-inguinal branches of the first lumbar nerve. The inter-

costal nerves pass forward in the intercostal spaces to the latter's anterior extremities, when they dip behind the costal cartilages and between the internal oblique and transversalis muscles to the sheath of the rectus which they perforate. The incision which we are describing does not involve the intercostal spaces as it merely severs the fused ends of the eighth, ninth and tenth costal cartilages and free tips of the eleventh and twelfth.

Only minute arterioles of the anterior branches of the intercostal arteries are severed, we have never had to ligate any blood-vessels. The phrenic and costophrenic arteries are not involved. Collateral circulation with branches of the internal mammary and deep epigastric arteries is abundant.

The external oblique muscle origin, by digitations alternating with those of the serratus magnus and latissimus dorsi, is only partially severed, its main attachment being to the costal margin from the seventh costal cartilage backwards. The internal oblique, transversalis and rectus muscles are not interfered with.

The incision may be extended a distance of thirty centimetres, with proper retraction the surgeon's hand penetrates through it quite readily. Dependent drainage is easily obtained, the posterior end of the incision corresponding anatomically to the upper end of the classical lumbar exposure.

Firm closure is obtained because the line of incision severs the costal cartilages one centimetre from the costal angle. The chondroplastic flap thus obtained enables one to close the diaphragmatic incision, with or without drainage, coapt costal cartilages individually and close the muscles and skin in separate layers.

We believe that the transthoracic extrapleural route fulfils all the desiderata of a paramedian abdominal incision, *i.e.*, avoidance of nerve injury, integrity of muscular origin and insertion, ample exposure and firm closure. With equal facility it can be made on either the right or left side of the anterior median line.

That opening of the pleuræ is always avoided through our incision becomes evident when one considers pleuropulmonary topography.

Antero-laterally, the lower margins of the lungs extend to

Sixth costal cartilage in the parasternal line,

eighth rib, mid-axillary line,

tenth rib, scapular line (6-8-10)

The lower margins of the pleuræ extend to

Seventh cartilage (lower border), parasternal line,

ninth rib, mid-axillary line,

eleventh rib, scapular line (7-9-11)

A thoracic incision beginning at the eighth costal cartilage in the parasternal line and running obliquely downwards, outwards and backwards to the tenth rib in the mid-axillary line and twelfth rib in the scapular line absolutely avoids the pleural sinus (8-10-12)

The pleural sinus is a triangular interval at the base of each pleural cavity, unoccupied by lung tissue. This empty space is about three centimetres high, so that the lower margins of the pleuræ extend the width of one rib below those of the lungs.

The diaphragm has been described as being attached anteriorly to the posterior surface of the xyphoid and internal surfaces of the seventh to twelfth ribs. Together with the pleuræ and lungs it forms a cupola which extends much lower behind than in front.

*The Incision*—(1) Identify the eighth costal cartilage in the parasternal line. As a rule its anterior tip blends in with the seventh cartilage but it may reach the sternum directly.

(2) Make an oblique incision from the centre of the eighth cartilage in

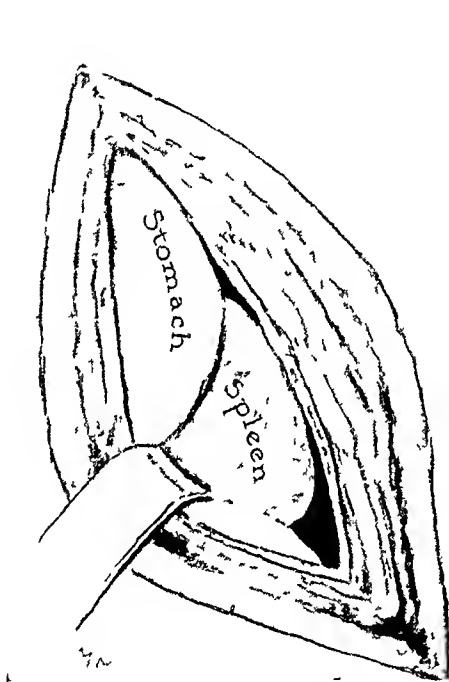


FIG 4—Left transsternal incision approach to spleen

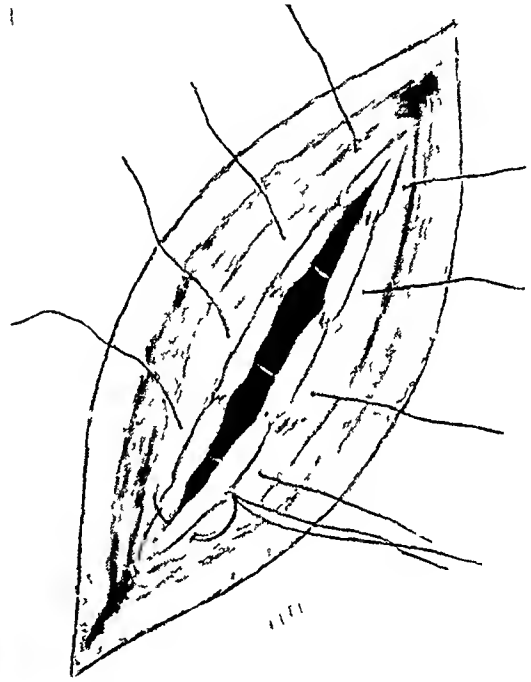


FIG 5—Retraction of costal cartilages

the parasternal line downwards, outwards and backwards. The soft tissues and cartilages are severed together, the incision lies one centimetre above the costal angle. An exposure as long as thirty centimetres may thus be obtained.

(3) Retract the costal cartilages upwards and the chondroplastic severed portion downwards. A rib separator of the Tuffier type is useful but not necessary.

(4) By blunt dissection separate the pleural sinus from the dome of the diaphragm and pack in a laparotomy sponge to protect it from the field of operation.

(5) Incise the diaphragm in a line roughly paralleling the costal margin.

(6) Having completed the operation, closure is obtained by suturing each severed cartilage with No. 2 chromic catgut threaded on a curved cutting

needle The severed sheath of the external oblique and intercostal muscle fibres are coapted by means of interrupted sutures The skin is sutured separately

(7) Drainage may be brought out through the posterior angle of the incision or through a still more dependent stab wound

*Variants* —(1) Whenever the clinical history and physical evidence presented enable the surgeon to localize the site of the abscess, only that portion of the incision which lies over the pus should be used In retrocæcal or retroperitoneal abscesses the posterior third of the incision will be satisfactory, in ecchinococcus cysts of the liver, the anterior third will often give sufficient exposure

(2) Should an empyæma be found after the chondroplastic incision has been made, the diaphragm is, of course, not to be incised

*Scope of the Extrapleural Incision* —(1) Diaphragmatic prolapses, congenital, idiopathic or traumatic According to Lenormant and Suter, the thoracic approach to diaphragmatic prolapses of traumatic origin gives a mortality of 5.6 per cent, whereas the abdominal route raises it to 33 per cent Military surgeons favored a primary thoracotomy in all abdomino-thoracic wounds, only resorting to a thoracolaparotomy when visceral wounds inaccessible by the upper route were encountered

In non-traumatic diaphragmatic prolapse, if strangulation of the viscus or viscera is present, thoracotomy is the safest route to choose Of eighteen cases operated upon via the abdominal route, only three survived (Fritzsche, Walker, Vieting), whereas the transthoracic route should not give a mortality in excess of 25 per cent In the absence of strangulation, if the prolapsed viscus is not too adherent, it can be replaced equally well from above or below the diaphragm, but suture of the latter is much easier from above

(2) Abdominothoracic crushing, stab or gunshot wounds involving the liver or spleen, with or without pulmonary or pleural wounds World War experience proved beyond cavil that the best method of handling such combined wounds was to enlarge the thoracic wound, if necessary, treat any lesion of lung or pleura and then, by enlarging the diaphragmatic wound, attack from above a wounded liver or spleen

(3) Sub-diaphragmatic abscesses Post-appendiceal, amoebic, traumatic, non-dysenteric

(4) Ecchinococcus cysts of the liver

(5) Combined supra- and subphrenic abscesses, regardless of their origin

(6) Splenectomy in non-traumatic cases or in traumatic cases not involving hollow viscera

*CONCLUSIONS* —(1) A simple approach to the diaphragmatic area, evolved as a result of World War experience, is submitted

(2) It does not involve opening the pleural cavity, gives ample exposure and its closure is not followed by herniation

(3) The incision is utilizable either to the left or right of the anterior median line



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## PULMONARY ABSCESS\*

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PULMONARY complications following operation are of sufficient frequency to be of interest to every surgeon. Of such complications lung abscess is attended with the highest mortality and a still greater morbidity. During the past fifteen years the incidence of suppurative lung conditions has increased tremendously, attributable doubtless to the greater number of operations done on the upper respiratory tract and also to the influenza epidemics of 1918 and 1927 with the attendant streptococci infections.

The basis of this paper is a study of forty-nine cases of lung abscess occurring during the past seven years. We have excluded from consideration those cavitations due to tuberculosis and bronchiectasis. Likewise, we have not considered those due to the aspiration of a foreign body, nor those due to various types of infection such as actinomycosis, *etc*, nor pulmonary suppuration resulting from bronchial obstruction due to new growth.

A study of our forty-nine cases reveals the fact that eighteen of them, or 36 per cent, followed some type of surgery. Thirteen cases developed in the course of pneumonia and in twelve cases we could not determine any cause for the pulmonary suppuration. Two cases occurred in blood-stream infections and in these the abscesses were small and multiple and were not discovered until autopsy. Two cases resulted from so-called influenza, one was due to actinomycosis and one to an aspirated foreign body.

As to the sex distribution, thirty-two occurred in males and seventeen in females. This agrees approximately with the usual incidence as given by most writers on the subject.

In those cases occurring as a post-operative complication of the eighteen cases in this group, the abscess was located on the right side twelve times as compared with six times in the left lung. Sixty-six per cent of these cases occurred between the ages of twenty and forty. The distribution being as follows: Ten to twenty, 2; twenty to thirty, 9; thirty to forty, 3; forty to fifty, 2; fifty plus, 2.

When one considers the number of tonsil operations done on children it is surprising that more cases do not occur in the earlier decade. Such observation leads to the conclusion that it is not the aspiration of blood alone which is the causative factor in the production of pulmonary abscess. Flick, Clerf, *et al*, in a study of 172 cases of lung abscesses found that 121 followed surgical operations. Of the number, 107 resulted from procedures about the mouth and throat, ninety-seven being tonsillectomies. The remaining fourteen followed other types of operations such as appendectomy, herniotomy,

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\* Read before the Southern Surgical Association, December, 1931

*etc* Clerf in a further study of seventy-seven cases following tonsillectomy found that four had been operated under local infiltration and seventy-two under general anæsthesia

It is our belief that the high incidence of lung abscess in the mid-period of life is probably due to the fact that at that time we find dental infections most common. Children rarely have pyorrhœa or infected teeth, hence the low incidence of the disease in the first decade

Of the eighteen cases where the abscess followed surgical procedures seven were due to tonsillectomies and eleven to other types of surgery, one a mastoid, another following drainage of a cervical abscess. In every case a general anæsthetic was employed and in all some ether was given

There is much controversy as to the route by which the infection gets into the lung—whether per orum by aspiration or through the blood-stream as an embolus. Many experimental studies have been made which show that either mode of infection can and does occur. The result of these various experiments and clinical observations has been well summed up by Kline and Berger of Cleveland from whom the following is quoted

"The clinical and experimental evidence for embolism is well presented in the excellent communications of Cutler, Schlueter, Weidlein and Holman, and of Fetterolf and Fox. This evidence as presented in a recent communication by Schlueter and Weidlein is as follows

"Our belief that post-operative lung abscess results from embolism, a mechanism produced by the dislodgment of an infected thrombus from the vessels of the operative area is based on the following facts

"(1) The definitely proved existence of the condition of fatal post-operative pulmonary embolism. This supposes the possible scattering from any wound of single or multiple emboli into the venous circulation

"(2) The frequent development of lung abscess after operations performed in infected or potentially infected fields. In this class we refer particularly to nose and throat operations, especially tonsillectomy, and to operations performed on the gastro-intestinal tract

"(3) The high percentage of occurrences after operations performed in mobile operative areas. Thrombi are easily dislodged from such regions as the pharynx and epigastrium. In operations on the brain in which the skull acts as a splint the percentage of post-operative pulmonary complications is almost nil

"(4) The not uncommon appearance after operations in which local anesthesia is employed

"(5) The failure to prevent post-operative pulmonary complications with the constantly improved methods of giving inhalation anesthesia

"(6) The greater frequency of lower lobe involvement. This is explained by the greater volume of blood and the more direct course of the pulmonary artery to these lobes

"(7) The often symptom-free period following the operation before the onset of the complication. If the aspiration mechanism were the causative factor, the appearance of the symptom would be early

"(8) The sudden pain in the chest that frequently constitutes the initial symptom and the often severe and stormy associated clinical course that often follows before rupture and evacuation occur

"(9) The acknowledgment by bronchoscopists that typical lung abscess is rare with the lodgment of foreign bodies even deep in the air passages

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"(10) The unsuccessful attempts at experimental production in animals by the introduction of infected materials by way of the air passages, either by transtracheal implantation or by aspiration

"(11) The comparative ease with which lung abscess can be produced by the intravenous injection of infected materials"

Although pulmonary abscess was produced in dogs by the intravenous injection of a large embolus containing staphylococci, pneumococci and colon bacilli, the process eventuated in healing and not in a progressively enlarging lesion. That such a progressive lesion was not produced is probably due more to the organisms employed than to the route. The experimental abscesses reported by these investigators are similar to the embolic pulmonary abscesses observed clinically in cases of septicemia and pyemia. In cases of this type in man observed at autopsy, the abscesses were invariably multiple, involving several lobes and varying in diameter from several millimeters to about 15 centimetres. In one case they were confluent in places. The gross lesions were grayish or reddish gray without appreciable odor. Many were just below the pleura, and this structure was frequently involved. Microscopic examination of sections stained by the Gram method showed clusters of staphylococci first within the lumen of a blood vessel, then within the walls, the lumen at that time usually containing a thrombus. Apparently following the inflammatory process in the walls of the vessel there was a spread of the staphylococci and of the suppurative process into the regional lung tissue.

Although of interest in connection with the evolution of embolic abscess already described, the experiments of Cutler and his associates, in our opinion, do not throw any light on the pathogenesis of the so-called typical lung abscess of man. The following facts are more convincing evidence that in these cases the organisms reach the lung by aspiration.

(1) The frequent occurrence of aspiration of foreign material is borne out by the finding at autopsy of deposits of coal pigment in the lungs of adults.

(2) Pneumonia undoubtedly following the aspiration of food particles and bacteria during the unconsciousness of coma or of anesthesia is an occasional autopsy observation. On microscopic examination, sections from these cases show the foreign material and bacteria in the bronchial branches and in the alveoli, surrounded by inflammatory exudate.

(3) It was reported by Myerson that bronchoscopic observations immediately following tonsillectomy under general anesthesia showed the presence of blood and mucous in the bronchial tree in 155 of 200 cases. Myerson concluded that the failure of evacuation of infected material is the most important factor in the causation of pulmonary abscess. Among the reasons given for this failure are the loss of action of the cilia, the lessened elasticity and compressibility of the lung and a local immobility. Furthermore, it has been shown experimentally that rabbits receiving considerable numbers of pneumococci in the trachea just beyond the larynx get rid of them without suffering appreciable involvement of the lungs, whereas in those animals in which the same number of similar organisms has been introduced into the air sacs an inflammatory process invariably develops.

(4) The production of pneumonia by intrabronchial inoculation of pneumococci in dogs by Meltzer and Lamar, in rabbits by Winternitz and Hirschfelder, and by intratracheal inoculations in monkeys by Cecil and Blake, proved that aspiration can explain the manner in which organisms reach the lung in man.

(5) There is evidence for the belief that the various inflammatory lesions of the lung may be brought about by the aspiration of the causative bacteria from the mouth during the deep sleep following fatigue. In much the same way ether anesthesia increases the opportunity for aspiration into the lung and at the same time renders the body incapable of expelling the foreign material.

(6) The occurrence of severe pulmonary inflammation containing innumerable bacteria following clean operations in clean fields on patients under general anesthesia

indicates that in these cases the bacteria are undoubtedly aspirated from the oral cavity. Likewise, in clean cases done under local anesthesia, the bacteria most certainly reach the lung by aspiration and not by embolism.

(7) An anatomic study, including examination of Gram and Warthin-Starry stained sections of early lesions of pulmonary abscess and of pulmonary gangrene, reveals that the process in these cases is one of inflammation starting in and about small bronchial branches. This is quickly followed, however, by changes characteristic of abscess when staphylococci or other pyogenic organisms predominate in the lesion, and more slowly by changes characteristic of gangrene when spirochetes, fusiform bacilli, and vibrios of the oral type predominate. The spirochetes are present not only in the area of necrosis but also at the advancing periphery.

(8) The experimental production in a rabbit of pulmonary gangrene by the intra-bronchial injection of material from a carious tooth containing innumerable spirochetes and fusiform bacilli is proof that aspiration of those organisms may produce pulmonary gangrene. This experiment is confirmed by those of Smith, who reported the production of experimental aspiratory abscesses in mice, guinea pigs and rabbits by the intra-tracheal inoculation of material from about the teeth of patients with moderately severe pyorrhea, containing spirochetes, fusiform bacilli and vibrios. More recently Crowe and Scarff, and Allen report the production of lung abscess in dogs by the intra-bronchial inoculation of material containing oral spirochetes.

Schluter and Weidlein state that in a census of recent writers forty declare themselves in favor of aspiration while only ten favor embolism as the direct cause of lung abscess. From the available evidence, the view of the majority is apparently the correct one.

We do not think it necessary to outline the symptoms of pulmonary abscess before this body. As a rule the condition is not diagnosed until the expectoration of a large quantity of foul-smelling pus. The fact should be emphasized of the possibility of the development of pulmonary abscess in every case having pulmonary symptoms after operation. The interval between the time of an operation and the appearance of an abscess is as a rule of short duration and in seven of our cases was from two to nine days. However, it must be borne in mind that the interval may be much longer and in one of our cases it was three weeks, in one four weeks, in one five weeks and in another case the interval between the operation and the development of the abscess was as long as two months.

The diagnosis of lung abscess in the typical case is not difficult but must always be differentiated from tuberculosis, bronchiectasis and especially interlobar empyema. A carefully taken history together with well-made roentgenograms will in most instances indicate the trouble and a thorough study of the sputum will confirm the diagnosis.

Rontgenograms to be of value in the study of pulmonary lesions should not only be made by the usual stereoscopic method but lateral plates should also be taken. These are of value both from a diagnostic standpoint and as a means of localizing the pathological process. In the X-ray study of suspected lung abscess lipiodol instillation should always be done as by this procedure bronchiectasis can be easily differentiated. On flat anterior-posterior X-ray films the differential diagnosis of interlobar collections of pus from intra-pulmonary pathology may be very difficult. Recently McNeill,

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of Louisville, has devised a technic by which the interlobar septa can be well demonstrated. It consists in having the rays pass through the chest parallel with the interlobar spaces. Several cases which we thought were either



FIG 1



FIG 2

FIG 1—G D. Showed haziness in right root with slight, hazy infiltration extending from same in the fourth and fifth interspaces and diagnosed as pneumonitis and suggestion of a hilum pneumonia and bronchiectasis. The fluoroscopic observation in the McNeill tilting position showed definite fluid in the right median interlobar fissure.

FIG 2—G D. Six weeks later showed clearing and absorption of the fluid and interlobar fissure with a residual thickening of interlobar septum and some slight inflammatory reaction extending from the root.

abscess or new growth were by this method of study demonstrated to be interlobar collections.

The aid of the bronchoscopist is most valuable in the study of intra-



FIG 3



FIG 4

FIG 3—T R. Showing unresolved pneumonia three weeks after onset of disease.

FIG 4—T R. Shows cavitation and abscess in area of unresolved pneumonia. (In FIG 3 the print has been reversed, the disease process being in the right lung.)

pulmonary lesions. By such examination foreign bodies not demonstrated by roentgenographic study may be discovered. Obstructions due to new growths can also be determined by this study. Jones in an article appearing in *The Military Surgeon* cites a case where the diagnosis had been pul-

monary abscess and the true condition, namely bronchial neoplasm, was not even suspected until its presence was demonstrated by bronchoscopy

*Treatment*—Lord has stated that about 10 per cent of the cases of lung

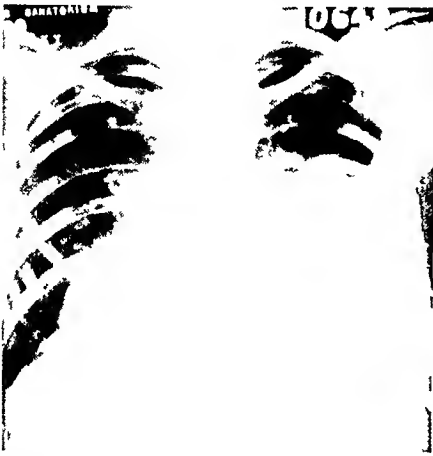


FIG 5

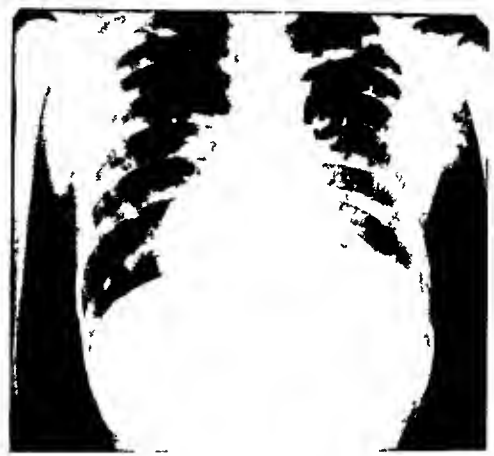


FIG 6

FIG 5—T R End result six months after external drainage of abscess  
FIG 6—R D, aged nine Pneumonitis and abscess formation right lung following operation for tonsillitis

abscess recover spontaneously and Graham puts the percentage somewhat higher. On the other hand the mortality of untreated cases is more than 70 per cent and the morbidity incident to delay in the institution of treatment is exceedingly high. In the therapy of pulmonary suppuration, as in the



FIG 7—R D End result eighteen months after thoracotomy and external drainage

treatment of tuberculosis, rest, sunlight and proper food is very important. Recovery is obtained only when the abscess cavity is obliterated and this according to Holman depends on drainage, contraction of the fibrous wall and the expansion of healthy lung.

Drainage of the abscess is therefore essential and it can best be in the non-operative treatment accomplished by so-called "postural drainage" which is obtained by having the patient hang the upper trunk over the edge of the bed with the head dependent, thereby allowing the pus to drain out of the cavity.

In such treatment the position mentioned should be repeated three or four times a day and even more frequently if thought necessary. By this method alone a number of cases will recover and this is particularly true where the abscess is thin walled and not of long standing.

Flick in a study of 172 cases found that 54 per cent recovered and 13 per cent improved by bronchoscopic aspiration. By means of the broncho-

scope resultant complicating strictures in the bronchus may at the same time be dilated and exuberant granulation when present, removed, thus permitting the more certain evacuation of the abscess. This method of treatment is applicable only to those cases where the cavity drains into the larger bronchi near the root of the lung. Moersch in 140 cases observed at the Mayo Clinic found that 105 were treated by bronchoscopy and reported fifty-one recoveries and eighteen improved by this method alone.

*Pneumothorax*—Treatment by collapse of the abscess cavity through artificial pneumothorax has only a limited field of usefulness. It should never be done in those cases where the abscess is near the periphery of the lung owing to the danger of rupturing the abscess and producing a pyo-pneumothorax. When the cavitation is near the centre of the lung and communicates freely with a bronchus, the collapse of the lung by the introduction of air into the pleural cavity is a very valuable means of treating this condition.

*Phrenicectomy*—Phrenicectomy is employed in the treatment of some abscesses located in the lower lung fields. The rise of the diaphragm following its paralysis may approximate the walls of the abscess cavity and so lead to its obliteration. It must be borne in mind, however, that in cases where the drainage is not free the rise of the diaphragm may cause obstruction to the drainage tract, thereby preventing the evacuation of the abscess and defeating the very purpose of this manoeuvre. When such obstruction does occur, instead of improving the patient becomes decidedly worse and so we feel that phrenicectomy should be employed only in very carefully selected cases.

*External drainage*—This procedure must be used when the other forms of treatment are without results. When the abscess is situated in the periphery of the lung and bronchoscopic drainage is useless, open drainage of the abscess must be instituted. Miller and Lambert have advised against the institution of external drainage when there is present active acute pneumonitis and it has been our practice not to operate until at least three months after the development of the abscess.

We employ the two-stage method and rarely use tube drainage, thinking it better to open the cavity widely and pack with gauze. Our results have been gratifying and to date we have not had a bronchial fistula. In one case, a post-operative abscess located in the right apex, we did use tube drainage and while this patient was markedly improved and the drainage tract closed she is still having some trouble and we later expect to re-open the cavity widely through an anterior approach.

In the diagnosis and treatment of pulmonary suppurations there should be close cooperation between internist, bronchoscopist, roentgenologist and surgeon. Frequent consultations are necessary and a carefully outlined regimen must be followed. Many cases may be cured without surgery but there is still a large per cent, 25 to 35, which must be operatively drained externally. Furthermore we would emphasize the value of McNeill's X-ray



technic in the differentiation of interlobar from intra-pulmonary pathology  
Of the large number of lung abscesses which follow operations, with careful pre-operative attention to infections about the teeth and the mouth many of these abscesses can be prevented

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## PHRENISECTOMY IN THE TREATMENT OF PULMONARY TUBERCULOSIS \*

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A MASS of literature on this subject already exists, so that it is not necessary to take up time and space with needless repetition of details and theory. It is my purpose in this short article to enter a plea for the early and more frequent use of phrenisectomy. With this idea in view, I have attempted to crystallize here my study of the subject from personal observations in Berlin, Vienna, and Davos, Switzerland, as obtained from the extensive literature available and from my own experience with this operation.

The term phrenisectomy as used in this paper is the operation known as phrenico-exaeresis and consists of the evulsion of the phrenic nerve to the length of ten cubic centimetres or more in order to produce a hemidiaphragmatic paralysis on the side of the affected lung.

For the history of this procedure, I refer the reader to any article written on the subject, for all of them are introduced by a historical sketch. The questions of importance here are: How did phrenisectomy come to take the important place that it does today in the treatment of pulmonary tuberculosis? What are its advantages over the other surgical methods in use? What are its dangers, and complications? What are its difficulties from the surgeon's point of view? What is the patient's attitude toward it? I wish to consider these questions especially in the light of comparison of phrenisectomy with other methods in use today.

The actual technic of phrenisectomy may be found in any book on surgery. I wish, however, to mention my preference for the transverse incision, as it leaves a much better cosmetic result, this matter assumes greater importance when the fact is considered that as more and more phrenisectomies are being done the scar will soon label the individual with this malady.

Originally, surgical procedure in pulmonary tuberculosis was applied in this order: First, artificial pneumothorax, second, thoracoplasty, then, thoracocautery, and lastly, phrenisectomy. Soon it was discovered that it was most important for the success of thoracoplasty to do a phrenisectomy first, for the following reasons: To stop the piston action of the diaphragm, to test the function of the other lung before introducing further surgical procedure to produce an improvement in the patient's condition by this minor operation before venturing upon the major procedure of thoracoplasty. Thus it was found that the patient frequently improved to such an extent that thoracoplasty could be omitted. The same happened in relation to thoraco-

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\* Read before surgical section of the Pan-American Congress, held at Mexico City, Mexico, July, 1931.

cautery After a considered Jacobæus operation was abandoned because of extensive adhesions, phrenisectomy was done as an alternative and was soon found to produce the desired effect As a result, phrenisectomy gradually moved up in order of importance until it stands second only to artificial pneumothorax It is my object by comparing the two methods to show that phrenisectomy is preferable to artificial pneumothorax even in early cases

The remarkable improvement in early cases of cavitation after the first artificial pneumothorax is a matter of common observation In order to maintain that improvement, the artificial pneumothorax has to be repeated and during these frequent repetitions there is a sudden retrogression due to the pulling of adhesions, the formation of fluid, or too much pressure, in other words, the early beneficial effects are spoiled by over-treatment If, in such cases phrenisectomy is first performed, it produces the same amount of compression as the early pneumothorax, the improvement in the patient's early condition is as great, and this improvement is usually maintained because there is no gradual loss of compression due to the absorption of air

The dangers and complications during a phrenisectomy do not present serious obstacles to the method There is, for instance, the dangers of complications brought about by the failure to recognize the phrenic nerve This, however, is remote in the hands of a man who has a right to undertake the operation

There is also a possibility of death from hæmorrhage by the tearing of the pericardiophrenic artery, the transverse scapular, or the subclavian vein Not an accident of this kind has occurred in my own practice, to Maendl and Schwartzmann in their treatment of 100 cases, or to Wirth and von Jaski, who reported 600, nor in Matson's 300 cases According to the few reports in the literature of such an accident, when it did occur, the patient was an old person in whom the phrenic nerve was twisted around the subclavian and the vein itself was very sclerotic In such a case it is highly probable that the fatality was due purely to the sclerosis The frequency with which an anomalous condition of the phrenic nerve is found in dissection—where it winds around the subclavian vein—would forecast a far more frequent accident to the vein, whereas, as a matter of fact, it is the rarest accident The relation of the frequency with which only a small section of the nerve can be evulsed during an operation bears a much greater relation to this anomaly, so that we may conclude that the wall of the vein is far stronger than the nerve and that the possibility of rupture of the subclavian is so remote that it may be ignored

The only other serious dangers are those of injury to the vagus or of air embolism due to injury to the jugular vein These complications occur only in the presence of tubercular glands or other inflammatory conditions in the neck In cases of this kind, phrenisectomy should be undertaken with caution

Minor complications have been reported occasionally, such as extremely rare cases of slight psychic disturbances of very short duration (dyspnœa is

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infrequent and transitory), extremely rare damage to the thoracic duct, and very uncommon instances of damage to the sympathetic nerve

On the other hand, complications and dangers in a pneumothorax are apt to occur much more frequently. In the first place, the number of operations on each person is so large that the possibility of accident is ever present. Secondly, the simplicity of its technic lays it open to the temptation of use by incompetent operators, whose name, unfortunately, is legion. Phrenisectomy, on the other hand, is seldom undertaken by medical men, and in the hands of a surgeon is a comparatively simple operation.

Hæmorrhage into the pleural cavity due to injury of the lung tissue or to blood-vessels where adhesions exist is an ever-present menace in artificial pneumothorax. It is also a known fact that in the hands of an inexperienced operator air embolism can easily occur in artificial pneumothorax.

The remote complications in phrenisectomy are almost nil, the exception being occasional gastric disturbances due to the dislocation of the stomach in cases of left-sided phrenisectomy. In artificial pneumothorax there are frequent effusions, which may become purulent, also mediastinal displacements causing embarrassment to the heart.

From the patient's standpoint, the balance is entirely in favor of phrenisectomy. They accept this eagerly in preference to the necessity of repeated treatments by pneumothorax over a period of years, particularly as many of these cases are patients who have to return to work and can ill afford the interruptions for regular refills. Also, phrenisectomy places less strain upon the recently infected other side than does artificial pneumothorax. And it is not surprising that a patient eagerly accepts the idea of a phrenisectomy in preference to the mutilating and deforming operations of a thoracoplasty and to the awe-inspiring thoracocautery.

It is only in cases of hæmoptysis that artificial pneumothorax should be resorted to in preference to phrenisectomy because of its quicker compression.

A big field for phrenisectomy lies in the treatment of bronchiectasis, lung abscess, resistant cases of pleurisy with constant pains and most especially bilateral pulmonary tubercular affections which exclude artificial pneumothorax and thoracoplasty from the start. After phrenisectomy the more seriously affected side conspicuously improves, the less affected side also shows frequent improvement.

In looking over the reports on phrenisectomy we find that the mortality is negligible. In fact, according to the most pessimistic report, there is a mortality of only half of 1 per cent.

Indeed, the general trend of all authors, after weighing all the tried procedures in accordance with their seriousness and importance to the patient, seems to be that the preferred sequence should be phrenisectomy, artificial pneumothorax if further compression is necessary, and thoracoplasty where artificial pneumothorax cannot add to such required compression.

In conclusion, I want to emphasize early phrenisectomy, which should be considered before artificial pneumothorax is undertaken. Nothing in phreni-

sectomy prevents the institution of pneumothorax later on. In a great many cases the tedious and long-drawn-out pneumothorax treatment will be avoided, especially if one does not lose sight of the fact that tuberculosis is a complex disease, and that other therapeutic measures must not be lost sight of in practising phrenisectomy. I repeat again what I have been emphasizing for the last twenty years. No one therapy can be used in tuberculosis to the exclusion of all others. When a new therapy is discovered, it should be added to our armamentarium and not used to the exclusion of important and still applicable therapeutic measures. Frequently, artificial pneumothorax has to be included in our most successful phrenisectomy. The status of tuberculin is not altered by the most successful phrenisectomy. The use of auto or stock vaccines in mixed infections retains its indication just as strongly after phrenisectomy as before. And the hygienic-dietetic-climatic treatment does not wane in importance in the face of phrenisectomy.

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# THE REPAIR OF INTESTINAL FISTULAE

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INTESTINAL fistulae may be due to (1) Ulceration due to pressure of tumors or foreign bodies (2) perforation of ulcer caused by disease processes, (3) intestinal fistulae made intentionally, (4) intestinal fistulae made accidentally (operation), (5) perforating wounds, or contusion of the abdomen with injury to the gut The fistulous opening may be (1) one in which the mucous membrane of the gut is adherent to the skin, (2) cases in which a fibrous tract or sinus connects the gut with the skin opening,<sup>1</sup> (3) temporary colostomy, (4) cases of faecal fistula complicated by compound fracture and hemorrhage, (5) cases in which one or more loops of bowel are connected with each other and open by a tract to the skin

The symptoms produced by intestinal fistulae depend upon the proximity of the fistula to the pyloric sphincter In fistulas of the duodenum and upper jejunum marked symptoms may be produced in a very short time if the loss of intestinal juices is great The urea and carbon dioxide content of the blood is greatly increased and the blood chlorides are decreased and death may result Ehlman and Hartman<sup>2</sup> have shown experimentally that death results because of the loss of gastro-intestinal secretions, and from circulatory and renal insufficiency due to dehydration The digestive action upon the operative wound may also be a serious complication A loss of nutritive substances to the body by the escape of the intestinal juices, with resulting emaciation of the patient, presents a very serious situation, so that healing of the wound may be impossible unless the digestive action of the juices can be inhibited and the nutrition and blood chemistry of the patient maintained at normal levels

This digestive action of the juices is found in fistulae of the small bowel and it may be present, according to Potter,<sup>3</sup> in any part of the intestinal tract in which the intestinal content is liquid He points to the fact that the pancreatic juices in the chyme prevent the healing of most of these fistulae That this is true, especially of duodenal fistulae and those of the upper ileum, seems reasonable In my experience, failure of closure of fistulae in the lower ileum and caecum are due to adhesions of the bowel, tuberculosis, or other disease of the caecum Fistulae arising from the large bowel are, unless intentional, more often produced by operative or other injury to the bowel and in this series of cases they followed removal of adherent ovarian cysts or were due to inflammatory processes in the pelvis

The fistulae in the lower bowel, while not so serious from the standpoint of loss of body fluid, are particularly dangerous because of the infective

character of the bowel content, and in their formation they are, as a rule, accompanied by peritonitis of varying degrees of severity. The formation of adhesions due to the peritonitis make closure of fistulae in this area a very formidable one.

This paper will consider the closure of fistulous tracts in which a sinus has already formed, and except for duodenal fistula, will not concern itself with the immediate treatment of the fistula and its subsequent peritoneal involvement.

Duodenal fistula, whether due to operative or other trauma, perforating ulcer or faulty technic in the closure of lesions of the duodenum is a serious condition. The dehydration from loss of intestinal fluids with an alkalosis due to the loss of chlorides from the gastric secretions produces very marked change in a short time. The patient rapidly loses strength and weight. The skin and mucous membranes become dry. The eyeballs become shrunken and glassy, and unless the condition is relieved, death ensues in from seven to ten days. The digestion of the tissues about the wound may be so severe that evisceration may take place. Healing is difficult or impossible. The following cases will illustrate this condition.

CASE I—Mrs E B, aged forty-two (Fig 1), entered the Presbyterian Hospital January 21, 1926, with the history of having had an operation for gall-bladder drainage one year before. She gave a history of typical gall-bladder distress, and under ethylene anæsthesia the gall-bladder was removed. The gall-bladder was adherent to the duodenum and the transverse colon, and on dissecting the gall-bladder free, the serosa was torn from the duodenum. The defect of the serosa was repaired, and closure of the abdomen was made with a cigarette drain in the right kidney fossæ. The drain was removed on the fifth day, and on the tenth day there was a small amount of drainage along the tract, so a small rubber drain was inserted. The patient left the hospital after two weeks with the drain still in place. Her husband was instructed to replace the drain if it came out of the tract and two weeks after returning home they reported that on attempting to replace the drain, the patient complained of a great deal of pain, and a short time later they found food material on the dressings.

The patient reentered the hospital March 30, 1926, for examination. Methylene blue given by mouth appeared in the sinus tract within five minutes, and from the character of the secretions we knew we were dealing with a duodenal fistula. The tract was injected with Beck's paste, but despite our efforts most of the duodenal secretion escaped. The skin about the fistula became excoriated, and the patient rapidly lost weight and strength. Rectal drip of 2 per cent glucose and hypodermoclysis of normal saline solution were given. Because of the large amount of secretions, an aspirator was used, and the wound kept as dry as possible by this means. Finally a gauze plug was inserted into the fistulous opening and a modified Beck's paste<sup>4</sup> was injected into the tract. The secretions gradually became less in amount and after fourteen days, the fistulous tract was entirely closed. This was corroborated by methylene-blue<sup>5</sup> tests and X-ray findings. The patient has been in comparatively good health ever since, and repeated fluoroscopic examinations have failed to reveal any filling defect as the site of the old fistulous opening.

CASE II—Miss M F, a nurse, twenty years of age, entered the Presbyterian Hospital, November 26, 1928. Two years previously she had a cholecystotomy, and one year later, because of recurring attacks of pain, the gall-bladder was removed at another hospital. A few days after her operation there was a discharge of food and

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biliary fluid from the wound. She was in the hospital for about two months and was discharged with a fistulous opening about the middle of the scar in the right upper quadrant. She had occasional chills and fever and upon entrance to the Presbyterian Hospital she said that during the last few weeks, the discharge had become greater in amount, was bile-stained, and contained food. The skin about the incision was red and excoriated. Methylene blue given by mouth appeared at the fistulous opening in seven minutes. The drainage tube was removed and the fistulous tract was injected with a modified Beck's paste. There was a stoppage of the discharge for about six or seven hours, and on re-injection, the discharge would stop for a similar period. The skin was painted with liquid adhesive plaster, and a gauze plug attached to a tube was

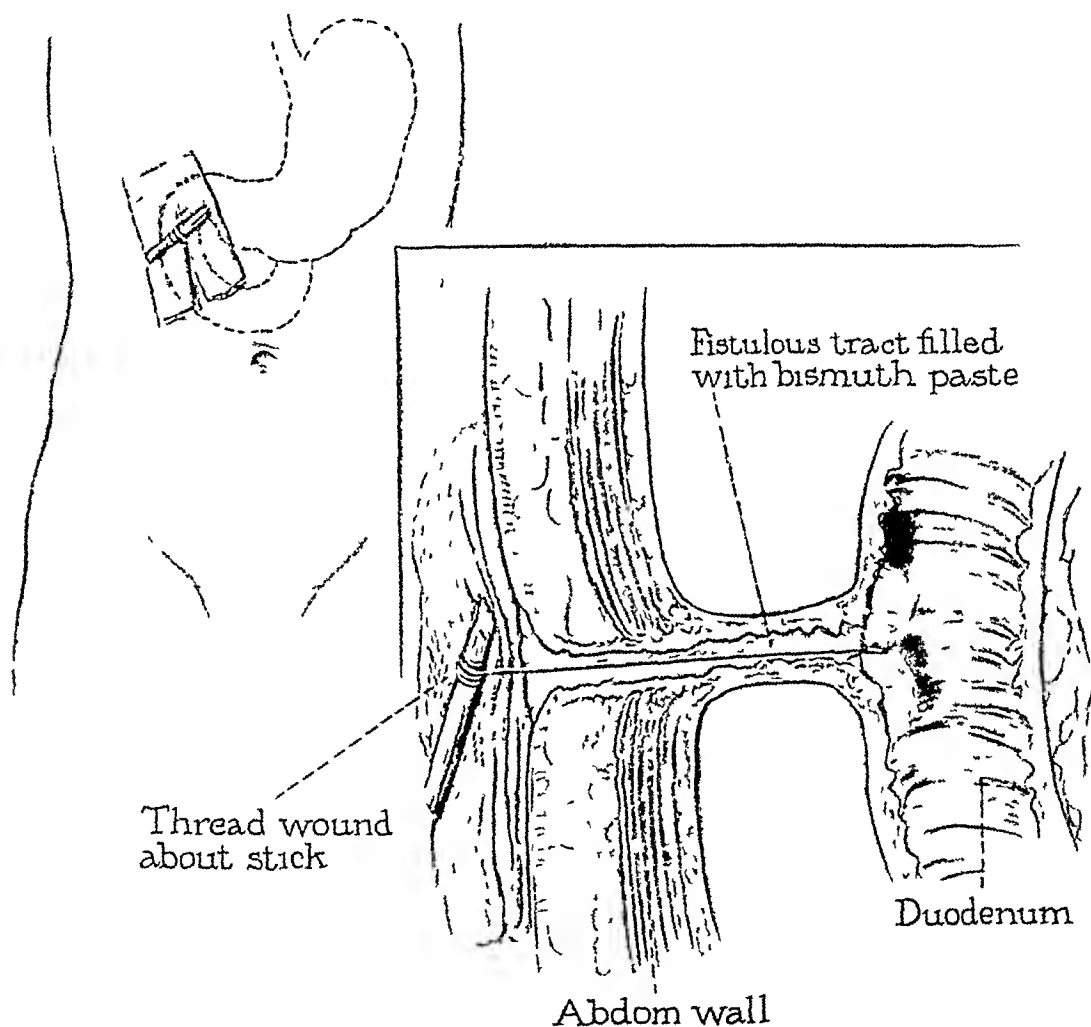


FIG 1—Closure of duodenal fistula

inserted into the fistulous opening and the wound injected with paste. Because of the loss of fluids due to the escape of intestinal content, she was given fluid rectally, and normal saline solution under the skin. There was very little drainage for about five days, after which time there was again a profuse discharge. The treatment was continued, and the patient left the hospital about one month after her admission with the fistulous opening closed. She returned two days later with the fistulous opening again discharging. The discharge was tested and found to contain free hydrochloric acid. The secretion became so profuse that continual suction was tried for three or four days. Because of the great loss of fluids, hypodermoclysis was again instituted. The fistulous opening was again injected with paste and a rubber balloon was inserted in the wound. The rubber balloon, however, caused so much pain, probably due to peristalsis, that it was removed. Modified Beck's paste was continued and three and



one-half months later, the patient was discharged with the wound entirely closed. She returned ten days later complaining of pain and vomiting. There was a slight, almost constant discharge of the fluid from the sinus. She was treated by a modified Sippy diet, and she was advised that operative interference would probably be advisable. Most likely a posterior gastroenterostomy with pyloric occlusion would be done. She left the hospital, went elsewhere where an attempted repair of the duodenal defect was made. The closure was only partially successful and the patient succumbed some months later to a pyæmia, her attending physician reported.

Fistulae involving the ileum, while not so serious from the standpoint of immediate loss of life, are of great concern in that a large part of the digested material is lost. The body fluids suffer and the patients lose weight though not to such a marked degree as in duodenal or jejunal fistulae. Digestion of the tissues about the wound may also be troublesome, and may cause a partial or complete separation of the wound. In this condition, however, the chloride balance may be maintained by giving 2 per cent sodium chloride solution by mouth, and supplementing it with hypodermoclysis. The intestinal juices that escape can be collected and sometimes re-injected into the lower segment of the bowel. A high carbohydrate diet of a soft non-residue variety will help to maintain the body weight. The fistulous wound can be protected by liquid adhesive plaster applied to the dry skin, while continuous suction of the wound may also be used.

The closure of this type of fistulae may be spontaneous as, for example, after enterostomy, or as in the following case, operative procedures may be necessary.

CASE III—W. N., aged eleven (Figs 2 and 3), entered the Presbyterian Hospital, February, 1931. He had been operated upon one year previously for acute suppurative appendicitis. There had been drainage instituted. A post-operative hernia had formed which had been repaired six months after his appendectomy. He gave a history of having had severe pain in the upper right quadrant followed by profuse vomiting.

He was seen by a physician at the time of the initial attack who advised his parents that he probably had an intestinal obstruction, and they were told to avoid the use of cathartics or sedatives. Later the family physician was called and though enemas, morphine, and castor oil were given, the patient did not improve, and upon entrance to the hospital forty-eight hours later, the patient was practically in a moribund condition. He was unconscious, his skin was cold and clammy, his temperature was 101°, pulse 150, white blood count 18,000, and the abdomen was distended and very rigid.

Under local anaesthesia, an incision was made in the right upper quadrant of the abdomen. Upon incising the peritoneum a large quantity of bloody fluid escaped, and a large gangrenous loop of small intestine was found. An adhesion at the base of the loop was broken up with the finger. Without attempting to particularly identify the bowel, the loop was brought out on the abdominal wall and closure of the wound was made as rapidly as possible. A normal saline solution was injected subcutaneously during the operation. The patient had a very stormy convalescence. Forty-eight hours after operation, 28 inches of gangrenous small intestine was removed without anaesthesia, and a fistulous opening from the small bowel remained. This loop was later identified as distal ileum. Four weeks following the enterostomy, the fistulous opening in the bowel was closed. The abdomen was reopened and a lateral anastomosis was made between the ileum and the ascending colon. The distal portion of the enterostomy loop having sloughed completely away, there was an opening at the ileocaecal junction. The gangrene

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of the small bowel had been due to a thrombosis of both arteries and veins to that portion of the small bowel involved. Three weeks following the lateral anastomosis, the



FIG 2—Ileostomy following intestinal obstruction

patient again had symptoms of intestinal obstruction. The abdomen was reopened and numerous adhesions were found along the distal ileum which were occluding the

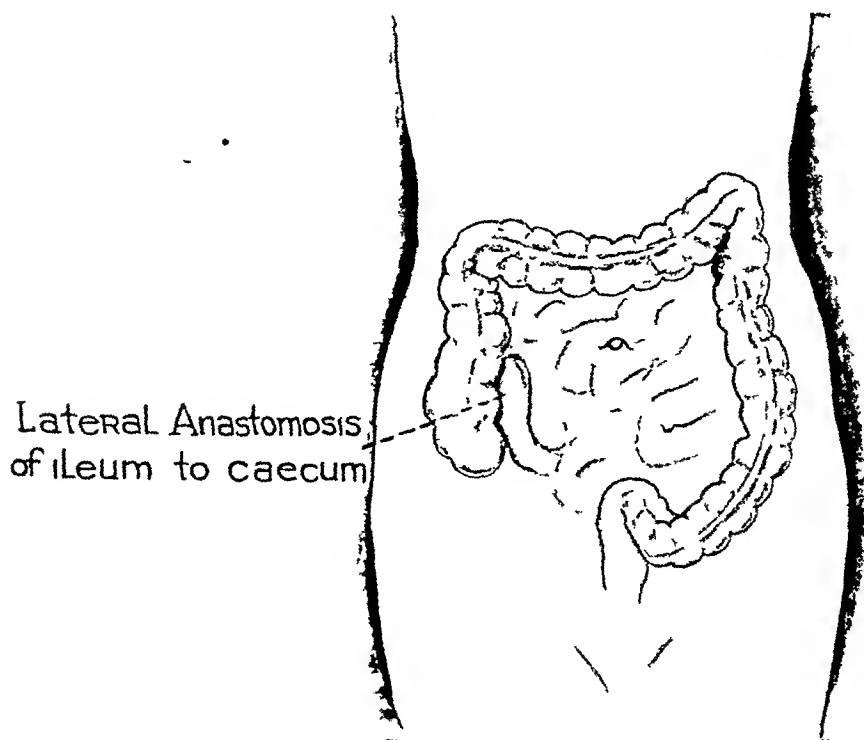


FIG 3—Lateral anastomosis following Ileostomy for intestinal obstruction

lumen of the gut. Because of the large area of small bowel involved by adhesions it was not thought wise to resect it. The numerous adhesions were broken up with the

finger The abdomen was closed in the usual manner The patient was seen ten months following the last operation He has gained about fifteen pounds in weight and is in fair condition

In the region of the cæcum, fæcal fistulas are not uncommon following appendiceal abscess or perforations of the cæcum due to foreign bodies, and as a complication of appendectomy where tuberculosis of the cæcum is present In fistula following appendiceal abscesses, closure is often spontaneous, and when the fistula persists, a suspicion should be entertained that we are overlooking some pathology about the ileocæcal region such as adhesions about the ileum, tuberculosis, or neoplastic diseases of the cæcum itself

Fistulae in this region may cause extensive excoriation of the skin, due

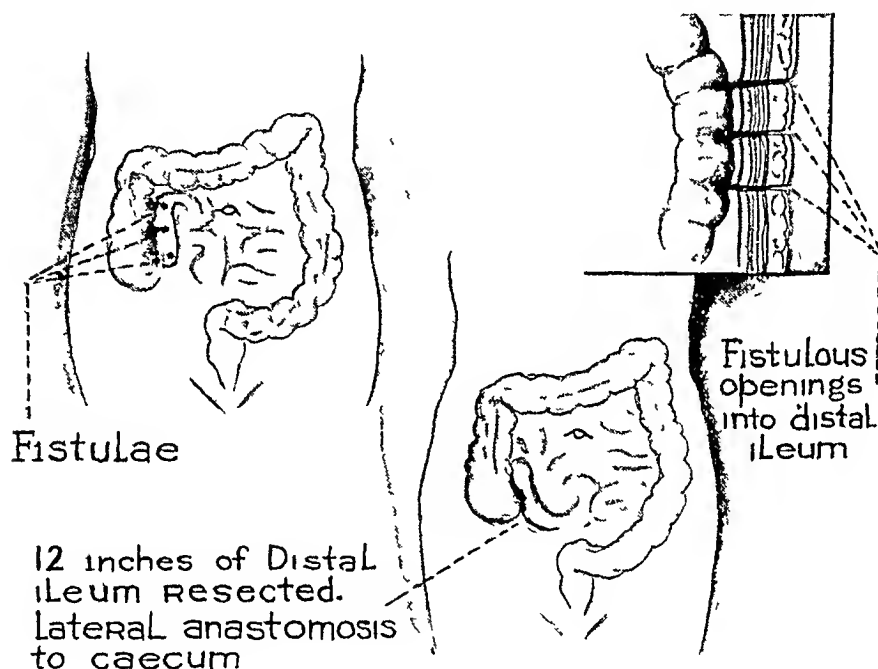


FIG 4—Lateral anastomosis for repair of persistent fecal fistula

to irritation of the fæcal current But by protection of the skin, this can be greatly eliminated There is usually a loss of weight present, and some dehydration, the latter, however, is not marked These patients often give a history of having had attempts made to close the fistulous opening, which have ended in failure The underlying pathology, such as tuberculosis of the lung, or emaciation, may give a clue to the true condition Fluoroscopy can be employed, either by the direct injection of the sinus itself, or by giving a barium enema The following cases illustrate this condition

CASE IV—Mr O, aged thirty-six (Fig 4), a patient in the Oak Forest Dispensary in 1925, had been operated at the Cook County Hospital two years previously for a suppurative appendicitis His present complaint was escape of fecal material from three fistulous openings in the right lower quadrant of the abdomen with marked loss of weight Because of inadequate X-ray facilities and a belief that the cæcum alone was involved, attempts at closure were made by dissecting the sinus tract down to the

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bowel wall, and closing the opening in the bowel with interrupted sutures. Two attempts were made, both being unsuccessful.

The patient reported to the Presbyterian Hospital and on injecting barium into the tract through a catheter it was readily seen that the cæcum as well as some portion of the small bowel, probably distal ileum, was involved. Under general anæsthesia, the abdomen was opened medial to the operative scar and 12 inches of the distal ileum, about 6 inches from the ileocæcal valve, were found adherent to the abdominal wall from which three fistulous tracts extended to the exterior. One of the tracts connected with an opening in the cæcum. The tracts were dissected free, the opening in the cæcum was closed, the ileum involved was resected and a lateral anastomosis was made between the cæcum and the ileum. The abdomen was closed in the usual manner without drainage.

The patient made an uneventful convalescence and gained 60 pounds in ninety days.

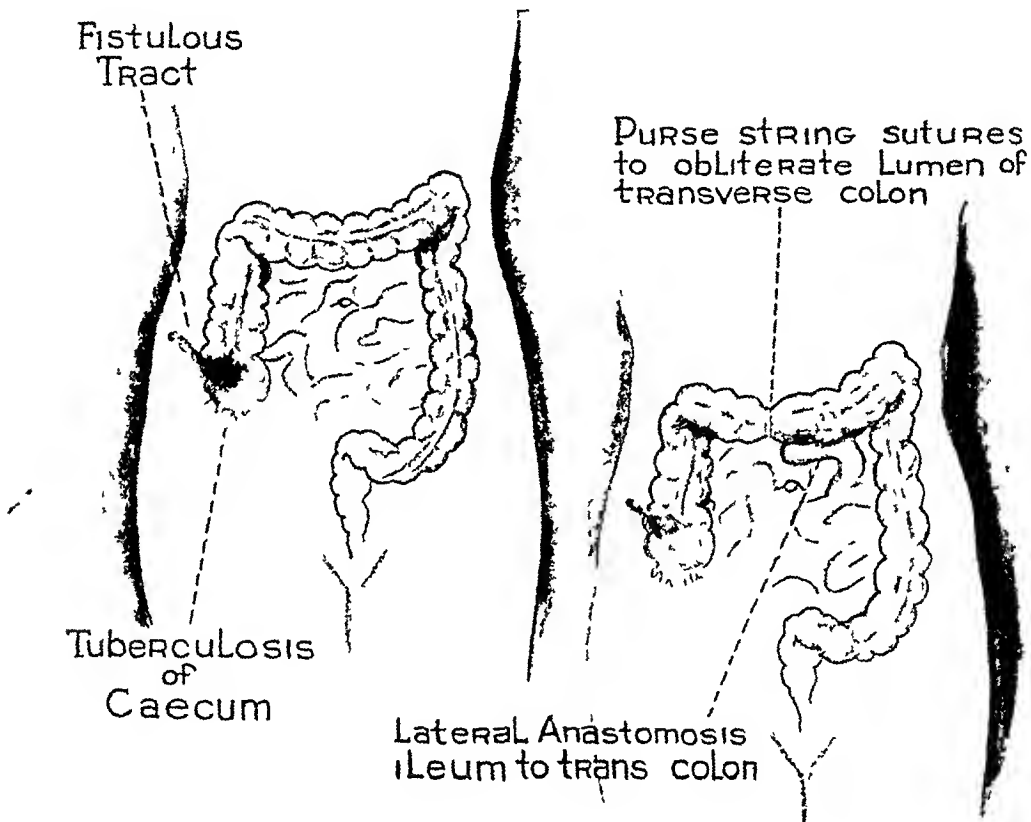


FIG 5.—Lateral anastomosis with obliterating of caecum

He left the Oak Forest Dispensary and returned to work and when last seen was enjoying excellent health.

CASE V—R J, aged twenty-eight (Fig 5), had been a patient at the Oak Forest Hospital for eight months with a fæcal fistula at the ileo-cæcal region. He had an appendectomy some time previously, at which time a diagnosis of ileocæcal tuberculosis was made. Following the operation of appendectomy, a fæcal fistula formed and most of the fæcal current passed through the fistulous opening. Because of the poor nutrition of the patient, it was thought that closure of the fistula should be attempted. Accordingly, a right rectus incision was made. The cæcum and ascending colon were found adherent to the surrounding structures. The ileum was resected, and an anastomosis to the transverse colon, at about its middle, was done. Because of the poor condition of the patient, the transverse colon was not resected. Three purse-string sutures were passed about the transverse colon, and the lumen of the colon, proximal to the anastomosis, was obliterated in this fashion. The abdomen was closed in the usual manner and a drain placed in the cul-de-sac.

The patient had a stormy convalescence, and when last seen, about six months later, he had a mucous fistula at the ileocaecal region. There had been some improvement in health, and some gain in weight.

CASE VI—E W (Fig 6), a colored male, twenty-five years of age, was transferred from the Oak Forest Tubercular Sanitarium to the General Hospital with the diagnosis of faecal fistula and pulmonary tuberculosis. He had been operated six months previously for what was thought to be appendicitis. Following his operation, he developed a faecal fistula at the site of the wound in the lower right quadrant of the abdomen. There were also numerous small fistulous tracts from which pus exuded. It was thought that if the fistulous tract could be closed, the nutrition of the patient might be so improved that his general condition would be better. Accordingly operation was advised.

Under local novocaine anaesthesia and nitrous oxide, the abdomen was opened medial

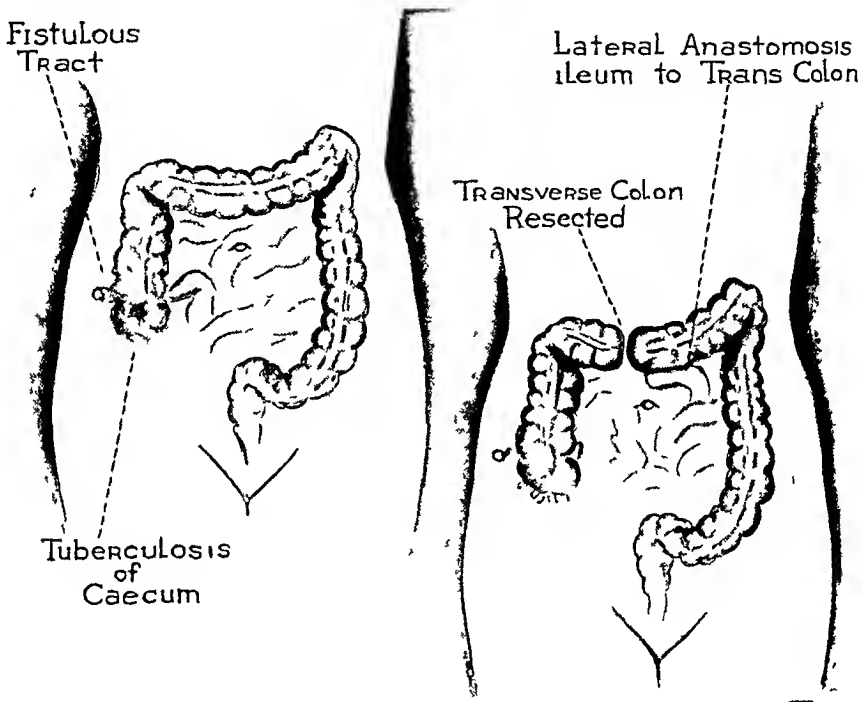


FIG 6—Lateral anastomosis with obliteration of caecum

to the site of the old scar. The caecum was found to be hypertrophic and adherent to the surrounding structures, so that colectomy was out of the question. Accordingly the transverse colon was resected at about its middle. The ileum was resected at the ileocaecal valve, and a lateral anastomosis made between the terminal ileum and transverse colon. The caecum, ascending colon, and a portion of the transverse colon were left in situ. The abdomen was closed without drainage.

The patient had a rather a stormy convalescence, and improved in health for one year. The fistulous tract in the meantime drained a muco-purulent material. He succumbed to miliary tuberculosis.

Fistulae of the lower bowel are of chief concern because of the accompanying peritonitis, and nothing more, as a rule, beyond drainage of the wound is indicated in the immediate treatment. With the formation of fistulous tracts it may be necessary to drain an abscess pocket which has prevented healing, or by regulating the diet to produce firm stools, the fistulae

may close spontaneously. Injection of the tract may be tried, if these measures fail. Operative intervention to close the fistulae should be reserved until all conservative measures have been tried.

CASE VII—Miss R. S., aged twenty-five (Figs 7 and 8), entered the Presbyterian Hospital, May 6, 1929, with the following history. Two years previously, the patient was operated for an acute suppurative appendicitis, following which she developed a pelvic abscess.

The abscess was drained supra-pubically, and following her discharge from the hospital a small fistulous opening was present at the lower end of the mid-line wound. This fistulous tract discharged faeces, and she said when mercurochrome was injected into the fistula, it would appear in the urine and faeces. Attempts were made to close the fistula by injecting mercurochrome, with the result that the bladder fistula closed, but the escape of faeces occurred nearly every day. Cystoscopic examination was done by Doctor Kretschmer, who reported that at about the juncture of the posterior wall with the base, there was a slight prominence of bladder, as though there was something outside of the bladder wall pushing it in. It was impossible to catheterize this depression, and this is probably the site of the closed fistulous tract. Under the fluoroscope a tube was inserted into the sinus, and lipiodol was injected into the sinus. The lipiodol passed downward to the left of the sigmoid colon and there appeared to be a large area which extended backward to the sacrum. Barium was then injected through the rectum, the rectum filled well. As the barium passed into the sigmoid loop it was continuous with the large tube-like lipiodol injection, in other words, this patient has a sinus connected with the sigmoid portion of the colon. The sinus tract was injected every other day with a modified Beck's paste. The discharge became less in amount, though at times the paste would be found in the bowel movements. Forty days later there was very little paste found in the bowel movements, and there was very little discharge from the sinus. The sinus was then injected with 5 cubic centimetres of 5 per cent formaldehyde in glycerin. The patient complained of bearing-down pains following this injection, but there was no further discomfort and this was done at weekly intervals during the remainder of the time she was in the hospital.

She left the hospital October 27, 1929. She remained in very good health for about one year, when she noticed that faeces were again being discharged from the fistulous opening. She again returned to the hospital May 25, 1930, and on May 26, 1930, the following operation was performed.

The mid-line scar was dissected free and the abdomen was opened. Loops of small gut and omentum were freed from the abdominal wall. The fistulous tract was traced down to the rectum, the tract in the rectum was dissected free and was closed with interrupted linen sutures. The descending colon was pulled out of the abdomen and was anchored in place for a temporary colostomy. The next day, because of the distention of the abdomen, the bowel was opened with a cautery. The convalescence was stormy. Ten days following the operation there was a partial evisceration, and the wound was closed with tension sutures without the use of an anaesthetic. The condition of the patient remained very good. The operative wound healed and one month later the spur of the colostomy was removed by the Pauchet method. The bowel was then covered with skin and muscle. The patient was discharged from the hospital October 2, 1930, with the fistulous tract closed. Her health improved. November 3, 1931, she returned to the hospital because of symptoms of low-grade obstruction. She remained in the hospital one day.

The fistulous tract is entirely closed and while her health is greatly improved there is always danger of recurrence of obstruction.

CASE VIII—Mrs. G. K., aged twenty-eight (Fig 9), entered the Presbyterian

Hospital, January 16, 1929, with the following history The patient was operated seven years ago for removal of a right ovarian cyst Following the operation, the wound

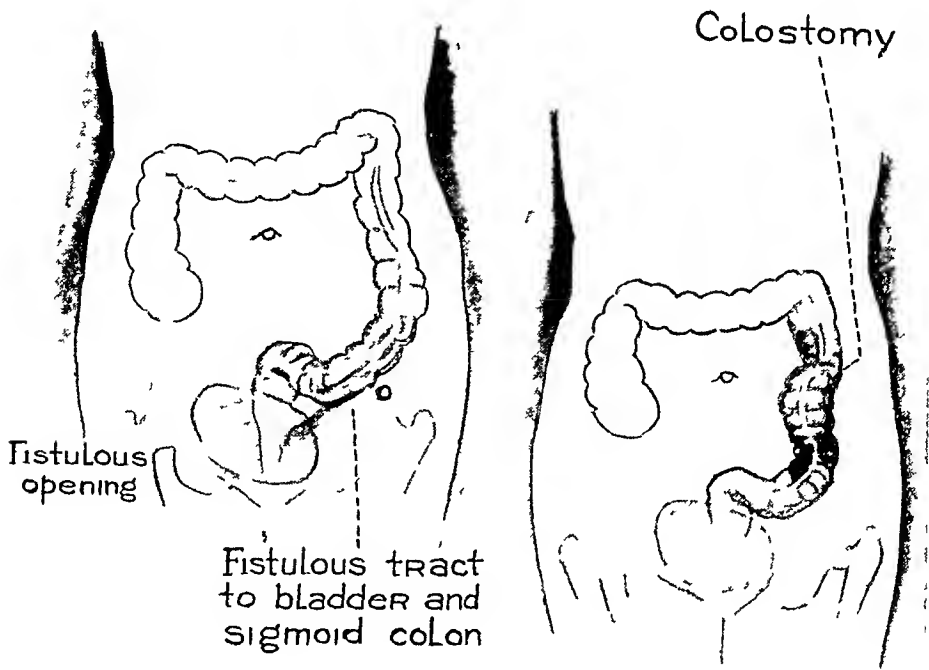


FIG 7—Temporary colostomy after repair of fecal fistula

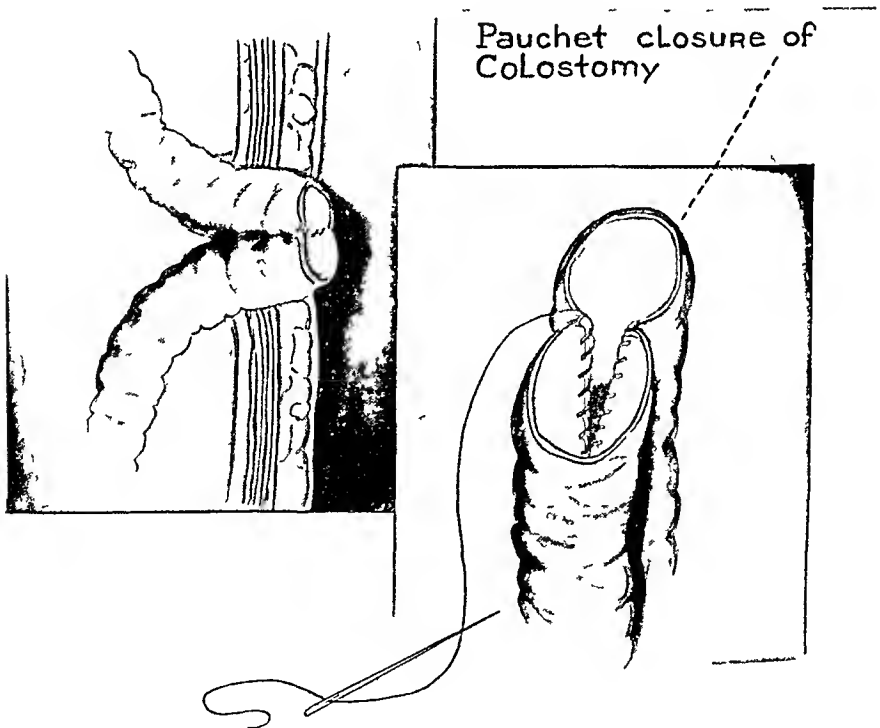


FIG 8—Pauchet closure of colostomy

drained for several weeks and a fistulous tract was established which has been present ever since, and from which faeces appeared nearly every day

## REPAIR OF INTESTINAL FISTULAE

There is a mid-line scar which extends from the umbilicus to the symphysis. At the lower end of the scar there is a small fistulous opening. At operation the old scar was dissected out and the peritoneal cavity opened. Omentum, small bowel, sigmoid colon and broad ligament, and a right-sided ovarian cyst, the size of a small coconut, were found in the dense adherent mass. The fistulous tract was dissected down to the sigmoid and to a seminecrotic area on the top of the bladder. During dissection, the bladder was ruptured with escape of urine. The sigmoid was dissected loose from its adhesion to the round ligament and to the ovarian cyst, and the fistulous opening in the sigmoid was closed with linen and reinforced by a fat epiploicae. A loop of ileum was pulled into the wound and a rubber tube inserted, and an ileostomy performed. The tear in the bladder was sutured, the ovarian cyst was marsupialized because it was impossible to remove it, and the abdomen closed without drainage.

The patient was in the hospital forty-nine days, and upon leaving the hospital there

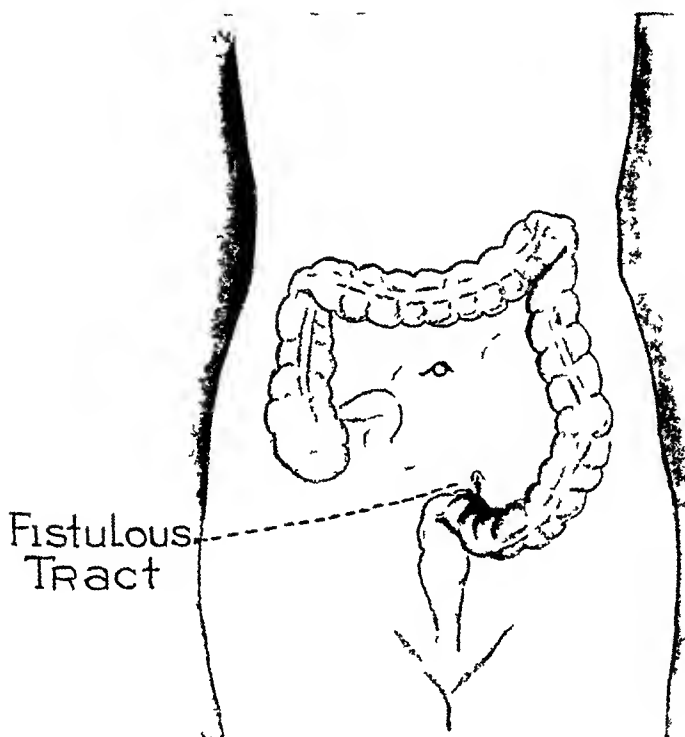


FIG 9—Fistulous tract for sigmoid colon

was no evidence of faecal discharge from the wound. June 28, 1931, she returned to the hospital because of three small draining fistulae at the lower end of the abdominal scar. The patient had improved in weight but because of the troublesome discharge from these fistulae, operation was advised. The old scar was dissected, two large ovarian cysts were isolated and drained, and the fistulous opening was again dissected down to the sigmoid. The bladder was again opened during the dissection, and was closed by catgut sutures. There was also a small defect in the ileum where the previous ileostomy had been done. This defect was dissected, and closure of the ileum was made. A Pezzer catheter was passed through the urethra into the bladder.

The patient remained in the hospital twenty-six days. When she was seen two months later, the wound had healed. There was a small opening at the lower end of the scar from which a mucous secretion was secreted. The patient was gaining weight, and felt better than she had felt for some years.

The treatment of intestinal fistula concerns itself chiefly with the location and chronicity of the lesion. In fistulae arising from the duodenum and lower jejunum the blood chlorides and body fluids, as well as body nutrition,



are of prime importance and measures should be directed to furnishing chlorides in the form of normal saline, and nutrition in the form of glucose, either by hypodermoclysis, rectal infusion, or by both methods. The fistula itself should not be treated by direct suture. In fact, so many failures have been reported that a conservative attitude should be employed. The skin and operative wound should be protected as well as possible, and this may be done with a liquid adhesive plaster, kaolin, or other ointments, and the sinus tract itself may be plugged with a modified Beck's paste. The pancreatic secretions may be inactivated by use of an acid media and continual suction of the wound may be advantageous. The treatment in this type of fistula is one of prevention, as many of them follow cholecystostomy or trans-duodenal removal of biliary stones. Care in breaking up adhesions about the gall-bladder with immediate repair of injury to the duodenum as well as careful suturing of operative incision in the duodenum, will greatly lessen the incidence of this very serious condition.

Fistulous tracts in the ileocecal region are more favorable for operative treatment than in any other region. The intestinal content is not highly infective, the peritoneal cavity shows a resistance to infection, and healing of the repaired viscera usually takes place.

In the lower abdominal tract, as many of these fistulae arise as a result of removal of adherent organs, gentleness during operative procedures and repair to the traumatized gut will greatly reduce this condition.

During the acute stage of fistula formation, the treatment is, of course, directed toward the local or general peritonitis, whichever is present. Many of these fistulae close spontaneously, and here too, the tract may be injected with a modified Beck's paste, and obliteration of the sinus may result. In the chronic type, however, operative procedures are a very formidable undertaking because of the dense adhesions present and the involvement of other organs by these adhesions. In the lower sigmoid a colostomy is often advantageous after the repair has been made. The colostomy may be closed several weeks later, and this procedure promises the best results in this type of fistula. The incidence of peritonitis following the operative repair is not so great as one would expect, and is probably the result of protective processes which have arisen from inoculation to the peritoneal cavity by the infected faecal current of the sinus.

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# INTESTINAL FISTULÆ

## A METHOD FOR PREVENTING DIGESTION OF THE SKIN

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THE management of intestinal fistulæ is difficult, due to (1) inanition and dehydration of the patient, and (2) the vicious action of the intestinal contents upon the skin and abdominal wall around the tract. It has long been recognized that the higher in the intestinal tract the opening occurs, the more irritating the discharge. The destructive action of high intestinal fistulæ is due largely to the presence in the discharge of unaltered pancreatic juice which is a rapid digestant of protein. Spontaneous closure of such a fistula might often be anticipated, or a successful surgical procedure considered if the ulcerated surface around the fistulous mouth could be protected from the continual assault by the intestinal contents. A method of accomplishing this protection is described in this paper. It has been used twelve times in this clinic with very satisfactory results.

Commentators on the subject have mentioned many drugs and methods which were thought to have been of value in protecting the skin about a fistula and in relieving the patient of the intense burning pain usually accompanying the lesion. Among the many dressings recommended are Olive oil, vaseline, zinc oxide, sodium fluoride, paraffin, benzoin, iodoform, kaolin, liquid petrolatum, acetic acid, glue, lanolin, *et ad infinitum*.

Ochsner<sup>1</sup> reported a case of cæcal fistula with marked digestion of the skin, much improved in three days by a diet of egg albumin. Closure was effected by operative means. Erdman<sup>2</sup> treated a duodenal fistula by a continuous suction apparatus suspended from a semicircular frame designed by Pool. A jejunostomy had also been made, and both openings closed spontaneously with this treatment only. Cameron<sup>3</sup> in a case with duodenal fistula following partial gastrectomy, used continuous suction by means of a catheter placed into the opening. Closure of the fistula occurred eleven days after the suction treatment was instituted, without operative assistance. Rees<sup>4</sup> treated a duodenal fistula, also following gastric resection, by dressings of whole milk (commercial). It is said to neutralize all of the ferments found in the intestinal discharge since it contains protein, carbohydrate and fat. Potter<sup>5</sup> reported a number of duodenal and high jejunal fistulæ treated by dressings of tenth normal hydrochloric acid and beef broth mixed with olive oil. The physiology of this procedure seems sound, since the alkaline discharge is neutralized by the acid, and the beef broth is a protein upon which pancreatic juice may direct its digestive action. Potter's<sup>6</sup> later report indicates that acetic acid is not a satisfactory substitute for hydrochloric acid in this form of treatment. Warshaw and Hoffman<sup>7</sup> modified Potter's method by introducing hydrochloric acid directly into the intestine at the opening of the fistula by catheter and by bathing the adjacent skin with Witte's peptone solution (10 per cent). They suggested the substitution of peptone for beef broth as the former is more easily prepared and readily procurable. Bohrer and

## INTESTINAL FISTULÆ AND THE SKIN

Milici,<sup>8</sup> in a recent report on duodeno-cutaneous fistulæ describe the use of a one-half inch fenestrated rubber tube in the fistulous tract to act as a reservoir for the discharge. A smaller tube, attached to a water-pump suction, is placed inside the larger tube and removes the discharge.

We have abandoned, some time ago, any attempt to protect the skin around an intestinal fistula by medicated dressings or mechanical covering, since these frequently shut off from contact with the air, a surface which would be better air dried. We now prevent, or minimize digestion and ulceration of the skin by keeping the irritating discharge from coming in contact with the skin about the stoma. The area is cleaned off with alcohol and dried, and no medication or dressing is applied. A continuous suction apparatus (centrally controlled) is used during the hours when the patient is awake. A glass-tipped rubber tube, in the hands of the patient himself,

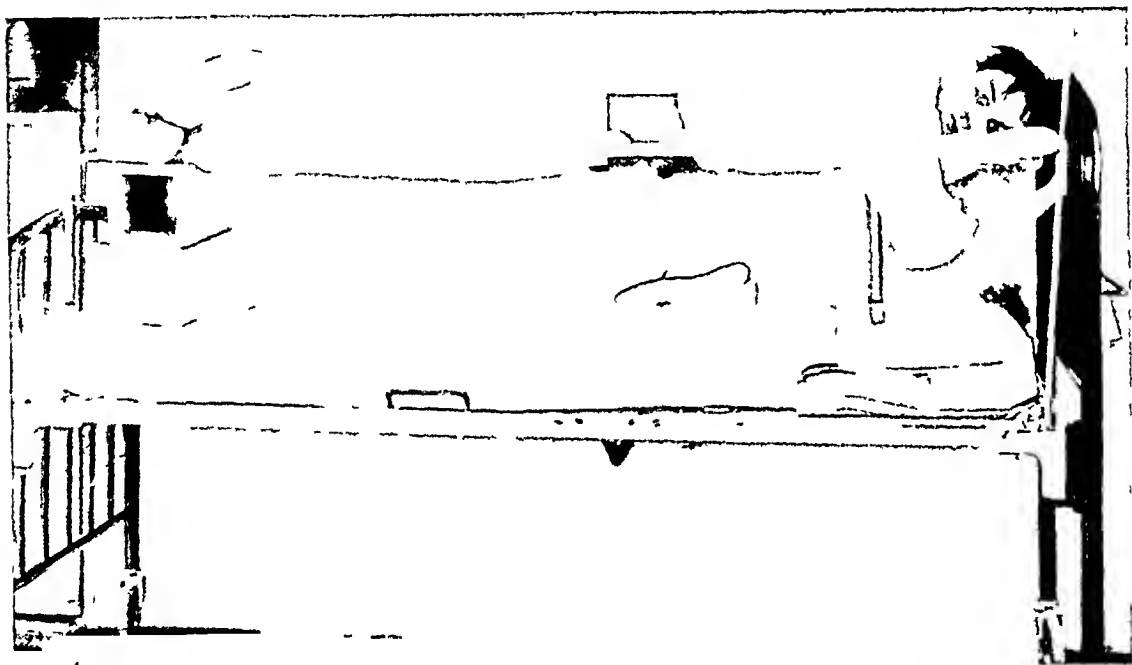


FIG 1.—Patient with fecal fistula lying on anterior Bradford frame showing opening in the frame. (Pillows under elbows have been removed for clearness of picture.)

has proved to be the most satisfactory method of applying this suction, since plugging of the tube, or cessation of the suction is immediately discovered, and may be corrected. This plan also provides the patient with an occupation which, though not exactly pleasant, stimulates his interest in his progress, and makes him a much better attendant than average nursing care affords.

The difficulty with this form of treatment has been that during the hours of sleep the discharge collects on the skin, and in a few hours digestion and erosion have occurred, vitiating the result of a day's careful attention. This problem we have found to be excellently cared for by placing the patient on an anterior Bradford frame (Fig 1) with a slit opening in the region of the fistula.

A bedpan, placed beneath the opening on the bed, serves as a receptacle for the discharge. Within a very short time patients accustom themselves to such a frame, and

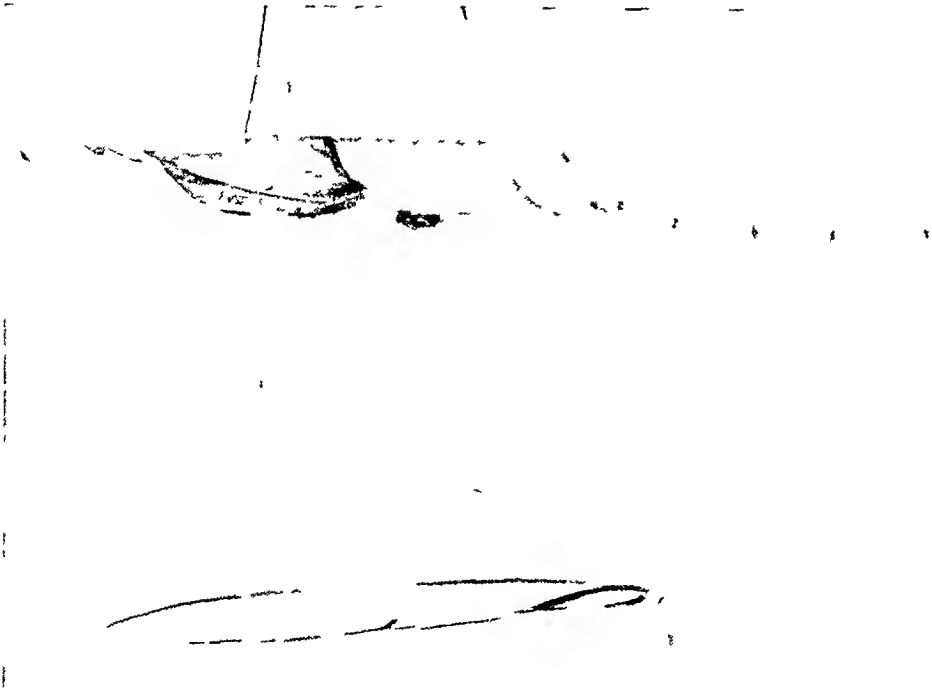


FIG 2—Close up of same patient as in Fig 1 showing prolapse of bowel. Note cleanliness of the skin despite the continuous discharge even while the picture was being made.

sleep comfortably through the night, as well as during a rest period in the day, with ideal care of the fistula requiring no conscious effort on the part of patient or attendants. The dependent position of the fistula, in most cases, tends to produce some degree of prolapse of the bowel mucosa (Fig 2) so that the opening in the bowel is some distance



FIG 3—Same patient as Fig 1. Pencil marking on skin outlines area which had been ulcerated from discharge. Completely healed at the time of the photograph.

## INTESTINAL FISTULÆ AND THE SKIN

from the skin surface. The fistula then assumes somewhat the character of a well-made colostomy, with the actual opening in the bowel far enough below the skin surface to prevent soiling of the skin as long as the patient lies in a prone position.

CASE REPORT—N. T., No. 253063, male, age thirty-two, entered the University Hospital November 10, 1930, complaining of a fecal fistula in the lower abdomen. A perforated appendix had been removed April 3, 1930. The abdomen was drained and within two days gas and feces escaped from the wound. Three attempts were made to close the fistula, six weeks, eight weeks and four months, after the appendectomy. The patient's general condition had become progressively worse with great weight loss, and pain about the fistula requiring large amounts of opiates for relief.

The patient was an emaciated, dehydrated male, acutely ill. In the right lower quadrant of the abdomen was a large fecal fistula surrounded by an area of ulcerated skin 12 centimetres in diameter. Several healed scars were seen in this region. Three openings into bowel were demonstrated, one of which discharged bile-stained fluid soon after the ingestion of water by mouth. The patient complained of extreme pain about the fistula, was ungovernable and for the first two days of hospitalization, required considerable narcotic. He was at once placed on constant suction combined with the anterior Bradford frame. Within four days healing of the skin had progressed so that the patient was comfortable and required no sedative. Ten days after admission November 20, 1930 the abdomen was sufficiently healed to permit surgical closure of the fistula. This necessitated resection of 15 centimetres of high ileum in which two openings were found, the third opening being in the lateral wall of the cæcum. Convalescence was not unusual and patient was discharged on December 24, 1930. Three months later he was entirely well and had gained fifty pounds in weight.

### SUMMARY

1. Drugs and dressings of various kinds applied to the skin surrounding a high intestinal fistula are not wholly satisfactory.
2. Greasy dressings seal the skin from the air and are distinctly of no value.
3. A continuous suction apparatus, operated by the patient himself, forms a satisfactory means of preventing digestion of the skin.
4. The prone position on an anterior Bradford frame provides the best care while the patient is asleep.
5. The time required for spontaneous closure or in preparation of the field for operation, may be appreciably shortened by the continuous suction and Bradford frame form of treatment.

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# THE PREVENTION OF FÆCAL FISTULA AFTER APPENDECTOMY

## SIMPLE LIGATION VS PRECARIOUS PURSE-STRING

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"Fewer errors occur in simple manipulative processes than in those of complex nature. The more we omit the multiplicity of detail and bring surgical technic down to an irreducible minimum of simplicity, the greater will be our reward in the ease and number of recoveries \* \* \* The easier the method, consistent with security, the sounder its qualifications"—ROYSTER

"The workman who does his work in as simple a way as possible usually does the best job \* \* \* Cumbersome, complicated ways of doing things are not allowable in the development of the art of performing surgical operations"—E STARR JUDD

"The surgeon must seek always and earnestly for simpler methods and a better way. In the craft of surgery the master word is simplicity"—MOYNIHAN

RECENTLY attention has been called by several medical writers to the general increase in the mortality of surgical operations, particularly appendectomy. One explanation which has been offered of this general increase is that quite generally throughout the country untrained physicians, though *legally* qualified, are undertaking to do major surgery. Prominent surgeons have discussed the matter, and there have been some suggestions of action by the American Medical Association, but nothing has developed and the profession in general seems quite apathetic. Legislation requiring a second examination of all doctors desiring to pose as specialists, so that those qualified for the specialty would be registered, would certainly aid materially in reducing the present death-rate following surgical procedures. However, the mortality of appendectomy cannot be entirely attributed to the inexpertness and poor judgment of amateurs, since a good many surgeons believe that it is in no small part due to the inherent dangers of a certain rather common method of operating.

The method referred to is the one usually known as the "purse-string," in which (1) the meso-appendix is detached from the appendix, (2) the base of the appendix (previously crushed in the technic of some operators) ligated with catgut or silk, (3) the appendix cut away about one-fourth of an inch beyond the ligature, by knife, scissors, or electric cautery, (4) the mucous lining of the stump of the appendix cauterized by carbolic acid or the tip of an electric cautery point, or the mucous membrane removed by a little scoop, (5) a purse-string suture, usually of six or eight stitches, inserted around the stump, (6) the stump depressed and (7) the suture tightly tied.

In looking through the different text-books, all authors are found to mention the purse-string method, and some of them seem to distinctly favor it. Thus, in Lewis' "Practice of Surgery" the chapter on "Appendi-

citis," as re-written for insertion in July, 1931, describes no other method but assures the reader that this method is "simple and safe"

Among the dangers of the purse-string technic is that its use necessarily cuts off a part of the blood supply to the area encircled. I once entered an operating room just as the operating surgeon had brought into view the cæcum from which he had removed an appendix by the purse-string method some three or four days before, the child had done well until a few hours before, when suddenly it went into collapse with great pain. *The encircled bit of cæcal wall had simply dropped out*, and the fæcal contents were pouring into the peritoneal cavity through an opening through which one could easily thrust a finger. The child was dying. Within a very few weeks I was told of two other cases of similar slough.

Harris,<sup>1</sup> of San Francisco, reports a case in which, at the time of the placing of the purse-string, the operator noticed that he had pricked a small vessel which caused a hæmatoma in the wall of the cæcum, but this seemed to be controlled before he closed the abdomen. The patient seemed to do well for three days, but then complained of pain with evidence of internal hæmorrhage, on opening the abdomen a large amount of free blood was found and the entire wall of the cæcum necrotic. The patient promptly expired.

Roeder,<sup>2</sup> of Omaha, found that of one hundred appendectomies made with the purse-string suture, 88 per cent of the needles and remaining pieces of suture gave positive growths on culture media, proving clearly that the needle had penetrated one or more times the mucous membrane of the cæcum. He also called attention to the added danger when the base of the appendix is crushed, since his laboratory investigation had shown that the crushing clamp was found to be frequently contaminated by the infectious material forced to the surface by the crushing process. Furthermore, the ligature which is placed in this crushed groove is not only in an infected field but in devitalized tissue very likely to give way from internal pressure, conditions very different from those described and illustrated by Seelig.

Horsley<sup>3</sup> calls attention to the perfect incubation chamber furnished by the purse-string enclosing the depressed stump, as presenting "first, the diminution of the blood supply to the tissues \* \* \*, second, the presence of necrotic material, and third, the formation of a closed sac",—all perfect conditions for abscess formation!

All authorities agree that the wall of the cæcum is the thinnest part of the entire alimentary canal and that the contents of the cæcum are the most highly infected. No author being found who gave the exact thickness, studies instituted at my request by physicians making frequent autopsies showed its thickness to be only *one-sixteenth of an inch*. The wall consists of four layers, the peritoneal, muscular, submucous and mucous. It would seem to be clearly an absolute impossibility for any man to put in the usual purse-string suture without running the gravest possible risk of penetrating infected tissue, so that his suture material would almost certainly become infected, as shown by the experiments of Roeder.<sup>1</sup> Indeed, Roeder informs me that he has found the wall of the cæcum one-half inch from the base of the appendix, where the purse-string is usually placed, only *one-thirty-second* of an inch thick!

A number of surgeons sever the appendix with the electric cautery, this



would certainly sterilize the surface actually touched by the cautery, but, as shown by Roeder, the tip of the cautery, if used to destroy the lining of the funnel of the appendiceal stump, does not always reach deeply enough to sterilize, and in this respect is greatly inferior to carbolic acid

Hamilton Bailey,<sup>16</sup> of London, in his recent work on "Emergency Surgery" fully describes his appendectomy technic, which is that of the purse-string, but directs that the stump be "wiped with a gauze swab," and then proceeds, without further sterilization, to bury it in the incubation chamber

Babcock<sup>4</sup> seems to trust entirely for sterilization of the stump to severing it with the actual cautery. As to the purse-string he adds "Purse-string, occluding, or enfolding sutures in the cæcum, after removal of an infected appendix, are unnecessary and harmful, favoring large sloughs in the head of the cæcum."

The one-sixteenth, or less, of an inch space in which the surgeon must insert his purse-string has always reminded me, and I think very appropriately, of the theological plight of Charles Wesley, as shown by a verse in one of his well-known hymns

"Lo! on a narrow neck of land,  
'Twixt two unbounded seas, I stand,  
Secure, insensible  
A point of time, a moment's space,  
Removes me to that heavenly place,  
Or shuts me up in hell."

The surgeon who undertakes to insert a suture in tissue one-sixteenth of an inch thick may possibly feel "secure," if not "insensible," but if the patient knew the narrow straight between sterility and infection—between safety and peritonitis—he would certainly feel very far from either "secure" or "insensible." Would any patient select a technic which gives from 14 per cent to 18 per cent of fæcal fistulas about one-half of them necessitating a second operation, in preference to a method giving only one such fistula in many thousand operations?

*Fæcal Fistula*—First place among the unfortunate "sequelæ" of appendectomy, is given to "fæcal fistula" by Royster<sup>5</sup> in his work on "Appendectomy." Howard A. Kelly<sup>6</sup> quotes five surgeons as having respectively 3.5 per cent, 5 per cent, 4 per cent, 18 per cent and 6.6 per cent of fæcal fistulas. Deaves<sup>8</sup> reported 4.8 per cent. Pfeifer and O'Connell<sup>7</sup> report 14 per cent, based on over 3,000 cases.

What particularly attracted my attention to the dangers of the purse-string was this large percentage of fæcal fistulas reported by surgeons who used that method. I could not recall a single one of my own cases in which I had met with any such complication, and this led me to go through my entire files, with the result that I found but one case in which anything like such a sequel appeared though I had operated on quite a number of such fistulas in which the primary operation had been made by a previous op-

erator The absence of such a complication in my own work seemed to me could only be explained by the difference in technic

Noting the reports of increased mortality of appendectomy and of this frequency of fæcal fistulas, I reviewed my own records and found that up to July 1, 1931, I had made 10,353 appendectomies Of the earlier ones some were made by excision of the base with closure by a double row of sutures, or by the inversion method of Edebohls, but the great bulk were made by the method of Seelig,<sup>14</sup> *viz*, ligation, amputation, carbolization, and dropping I always had a feeling that the purse-string suture was a dangerous proposition, and therefore could never bring myself to employ it because of what I thought were its inherent dangers With very few exceptions, as in cases which were operated upon at distant homes or in hospitals outside of Columbus, all of these patients, without regard to social or financial status, were carefully studied by me before operation and in the after-treatment were seen by me once or twice each day, of each case I have quite full typewritten histories These cases, therefore, are in distinct contrast to many hospital cases which are seen by the operator only at the time of operation

During all these years I have had a salaried first assistant, and in going over these statistics I supplemented the information thus obtained by a personal communication with each one of these assistants, not one of whom could recall a single case of post-operative fæcal fistula, except as stated That one case occurred in a man sixty-four years of age, with a gangrenous appendix, parts locally otherwise in good shape, and no drainage was placed He promptly developed a superficial infection in the fat of the abdominal wall, which discharged and after a few days extended inward, in two weeks resulting in a fæcal discharge In due time this drainage ceased of itself, but there still persisted a purulent sinus which annoyed him so that six months later it was dissected out, the removal of the sinus, which had developed a distinct lining, ended his whole trouble and he is now, ten years later, still alive and well

Taking for illustrative purposes the year in which the number of appendectomies was the largest, 141 were made primarily for appendicitis, and 392 incidentally in connection with other operations, eighteen were made for simple acute appendicitis, sixty-seven for chronic or subacute appendicitis, forty-five for gangrenous appendicitis (fourteen of them requiring drainage), eleven for abscessed cases The deaths were

(1) Boy, aged sixteen, operated upon on the sixth day at his home, condition bad and prognosis almost hopeless General purulent peritonitis found as feared, and the appendix found free in the pus Free drainage, but death in a few hours (2) Woman, aged forty-three, in bad shape for four days General purulent peritonitis, appendix thoroughly rotten Free drainage, bad prognosis, death in a few hours (3) Male, age forty Usual symptoms of appendicitis for one week, but had been treated for "colitis" *Repeated chills* Very large retrocæcal abscess, free drainage Continued symptoms of pylephlebitis, and death from exhaustion in five weeks (4) Chinaman, aged fifty-eight, sick five days Had been freely purged Extensive peritonitis, rotten

retrocæcal appendix with two concretions, free drainage, died the next day (5) Male, aged thirty-six, had had several previous attacks but had refused operation, in bad shape Gangrenous appendix back of the cæcum with much local infection Died one week later of general peritonitis

Physicians who may have been led to question the existence of such an entity as chronic appendicitis should read the discussions on that subject by the late John B Deaver,<sup>8</sup> the distinguished Philadelphia surgeon, and the more recent article by Roy D McClure,<sup>9</sup> Chief Surgeon to the Henry Ford Hospital of Detroit

That the use of the purse-string is not followed by a prohibitive mortality can only be attributed to the powers of the peritoneum to take care of any reasonable amount of infection, but there is necessarily a limit to those powers, and to surgeons who have used the simpler technic the dangers of the more complicated method seem so great as to render its employment entirely beyond the pale of safety

All surgeons will admit that the purse-string method presents a very pretty appearance, and from the outside looks very surgical, but when one considers what may be going on below the purse-string he might readily think of the "whited sepulchers" of St Matthew, "beautiful outward, but within, full of uncleanness"

One cannot but consider, in these cases of fæcal fistula, that the occurrence of the fistula probably saved the patient's life, since otherwise death would have resulted from the extension of the infection in other directions, and there would seem to be no question as to infection, coming from some of the needle punctures of the cæcal wall, being responsible for many deaths which have been credited to "peritonitis" Moynihan's<sup>10</sup> "N" suture is a trifle safer than the usual purse-string, since it requires but four instead of the usual six or eight stitches, but as he crushes the appendix with a Doyen clamp before ligating he increases the danger

Bailey,<sup>16</sup> of London, in writing on fæcal fistulas quotes approvingly an aphorism of a former colleague of his "If a patient with peritonitis develops a fæcal fistula, he does not die", his explanation being, of course, that a fæcal fistula acts as an enterostomy In a considerable number of cases I have been called in consultation when the patient's condition after operation was hopeless, general peritonitis was present in all of them, and inquiry showed that the purse-string had been used in each of these cases A number of years ago Dr Robert T Morris, of New York, published an article detailing his technic, which was the same as Seelig's Recently in response to a letter of inquiry as to fæcal fistulas, he replied that he *had had none since he adopted that method*

Perhaps the lack of fæcal fistulas in my records may be due in part to the fact that if the base of the appendix is involved with some infiltration of the adjacent wall of the cæcum, the involved portion of cæcum is removed by an elliptical excision and the opening closed with a double row of catgut stitches Repeatedly interns or nurses have anxiously reported

the presence of a fæcal fistula, but examination has shown a simple colon bacillus infection in the superficial fat which promptly cleared up, the intern having trusted to the odor in making his diagnosis. It is reasonable to suspect that surgeons who have reported numerous fæcal fistulas have likely trusted to such statements of the attending nurse or intern without making a personal examination.

As it might very properly be said that statistics based in part on the routine removal of the appendix when operations were made for other conditions, would hardly be a fair criterion as to the appearance of fæcal fistula, it may be well to state that my records show that 3,215 operations were made for appendicitis, so that, according to the best published statistics available, there should have occurred at least thirty-five or forty fæcal fistulas.

The chief objections to the purse-string treatment are (1) It requires much more time, (2) it necessitates more mobilization of the cæcum, (3) there is very great danger (88 per cent according to Roeder) of the needle penetrating the bowel with resulting peritonitis, (4) distinct danger of a hæmatoma from pricking a vessel, (5) danger of necrosis of the encircled wall of the cæcum from diminished blood supply, (6) great increase of post-operative adhesions, with resulting post-operative ileus, (7) greatly increased danger of fæcal fistulas, (8) the constant menace from burying the necrotic stump in a perfect incubation chamber.

By correspondence and by reference to surgical literature I find that the purse-string method is condemned by many surgeons of large experience, most of whom are professors of surgery in medical colleges, and all are men of national and international reputation, so that their opinions are certainly entitled to grave consideration.

The simple drop method which was in vogue at Mt Sinai Hospital when Seelig wrote his article condemning the purse-string, I am assured by one of the staff, is still in use by its twenty surgeons, and Berg, of that hospital, writes me that "it has been the method of choice there for the last forty years. I have used it in thousands of cases and have never known a fæcal fistula to develop after its use. The procedure is surely the simplest procedure that can be employed. The method is speedy and safe."

*The Safe Incision*—When McBurney brought out his incision for appendectomy it seemed so satisfactory anatomically that I at once adopted it and used it for a considerable time, and even occasionally resort to it now, but I found in so many cases that the space afforded was so small, and the different methods suggested to enlarge this space so unsatisfactory, that I abandoned it as a routine and adopted instead the method advocated by Deaver and others, by which a straight longitudinal incision is made through the right rectus muscle, the point of making the incision being determined by the anticipated underlying conditions. This incision can be enlarged in either direction, and the surgeon is at once master of the entire situation, while the closing of the incision is a straight piece of work. Some writers have objected to it as requiring numerous ligatures, but no ligatures are

necessary except when the deep epigastric has to be cut, when a single ligature is sufficient, other bleeding points are simply caught by a hæmostat for a few moments and bleeding always stops. I have never had any trouble with paralysis of the muscle from interference with its nerve supply. Surgeons who still favor the McBurney incision should read the article by Southam,<sup>11</sup> who condemns that incision because of the marked frequency with which an inguinal hernia develops after its use.

I am very certain that in scores of cases I have been able to coax a thoroughly gangrenous and tense appendix out through a right rectus incision which would unquestionably have burst had I undertaken to bring it out through a McBurney incision. Such successful removal makes all the difference between complete closure and drainage with its dangers.

*Routine Appendectomy*—For many years I have advised and practiced the routine removal of the appendix in all cases in which the abdomen was opened, except when it might be found apparently normal in adults, or the condition of the patient such as to preclude any further operative procedure, no matter how simple. In 1903, I published a short paper<sup>12</sup> advising such removal, in which I reported 636 such cases, together with the conditions found at removal. In looking through my notes of the thousands of cases operated upon since then, I find practically the same relative proportion of the conditions thus found, except that in two or three cases I noted that the appendix was full of pus. *In not a single case was there the slightest evidence of complication following removal of the appendix, nor that its removal had been responsible in any way for any fatal issue.* The following conditions were present in the 636 cases: Thickened, 126, adherent to intestines, 90, to gall-bladder, 4, to omentum, 3, to ovary, 30, to fallopian tube, 36, partly obliterated, 65, club-shaped, 63, constricted, 22, thickened and swollen, 116, containing fæcal concretions, 13 (3 concretions in one case, 5 in another, and a seed in a third), cystic, 2, twisted upon itself, 23, atrophied throughout, 15, apparently normal, 27.

While surgeons in general seem fully to appreciate the wisdom of routine examinations of the appendix, there are still a few who advise against it and themselves ignore it, or if they incidentally examine are very loath to remove it. If such surgeons use a complicated method of removal their attitude is probably wise, but if they employ a simple method it is doubtless wrong.

Many years ago I operated on a man for a pistol wound of the stomach, both walls being perforated. I carefully closed both openings, but because of his bad condition did not examine the appendix. In a few days unfavorable symptoms developed, which I attributed to a leaking stitch, but the autopsy showed the field of operation in perfect shape and death to have been due to peritonitis from a gangrenous appendix. The patient was insane, so that his death, while no calamity, afforded a valuable lesson.

Soon after this a babe, seventy minutes old, was brought to me with a hernia into the umbilical cord. The intestines could be readily seen through the amnion, and at one point was a discharging sinus which I assumed was probably a Meckel's diverticulum, and such was found to be the case at operation. The diverticulum was removed.

after the usual appendectomy technic, the abdominal opening closed in the usual way and the babe at once taken home. It continued to cry, except when asleep, from the time it was born until its death on the third day after operation. Autopsy showed a perfect peritoneum, the stump of the diverticulum had disappeared and the surface at that point was completely peritonealized, not an adhesion was present. Conditions were not favorable for a thorough autopsy to find the cause of death. It was, however, a perfect demonstration of nature's method of caring for such stumps.

*Operative Technic*—The right rectus incision is rapidly made. If the intestines crowd into the incision they can easily be pressed back and to the left by inserting *moist* gauze sponges, making a coffer-dam if pus is suspected. Usually the appendix is readily exposed, but if it is not it can be quickly found by the following manœuvre. The assistant, standing on the left of the table, holds the cæcum, which has been brought out, with his right thumb and forefinger, and the lower end of the ileum with his left thumb and finger just below the junction of the two the appendix, no matter if subperitoneal or how thoroughly covered by adhesions, will at once be found, and can be reached by separating overlying tissues with the handle of the scalpel. This use of the scalpel almost invariably exposes the appendix at its very origin, so that its subsequent removal is easy. This manœuvre is especially valuable in cases in which from extensive adhesions the longitudinal bands cannot be readily identified. (The relationship of the appendix to the cæcum and ileum may be compared to that of the genitals of a baby to its legs when the nurse holds the latter abducted and drawn up.)

The meso-appendix is ligated by transfixing it with a hæmostat and withdrawing a chromic catgut ligature. (Usually a single ligation is all that is necessary.) The meso-appendix should be ligated and detached as close to the base of the appendix as possible, so as to leave a minimum of stump with resulting minimum of possible adhesions. The appendix, with the remains of the meso-appendix attached, is brought up and ligated *tightly* with chromicized catgut No. 2 at its very base, so as to get below Gerlach's valve. Holding the ends of the ligature between the thumb and forefinger, the finger close to the knot, with the tissues below properly protected, a hæmostat is placed on the appendix a little above the ligature and the appendix cut away with knife or scissors, leaving a "button" of three- or four-sixteenths of an inch. With a probe dipped in pure phenol the edges of the appendix stump, and its funnel-shaped cavity lined with mucous membrane, are thoroughly touched, *being careful that the phenol reaches the very bottom of the funnel*. Any surplus phenol is wiped off, but the application of alcohol, as recommended by some who evidently are ignorant of the investigations made at the Johns Hopkins,<sup>13</sup> is entirely superfluous. The ligature is then cut short, and the stump of the appendix dropped. One-eighth to one-quarter of an inch has been left as a "button" to support the ligature.

The stump, thus dropped, and also that of the meso-appendix, almost invariably disappear from view, but if either projects so as to be a possible

point for adhesions it can easily be covered by a stitch or two so placed as by no possibility to penetrate the bowel

The gauze sponges are then withdrawn, the omentum pulled down and spread out smoothly, and the incision closed by a continuous chromic catgut suture embracing the transversalis fascia and peritoneum, carefully turning the edges outward so that there will be no raw surface next to the underlying parts, with the same suture a running stitch is carried back approximating lightly the edges of the split rectus muscle, and then, still with the same suture, the aponeurosis of the external oblique is carefully approximated, several silkworm gut stay sutures are then placed, embracing all the tissues down to and including most or all of the thickness of the rectus muscle. These stitches being tied, all dead spaces are obliterated into which otherwise blood might ooze with a resulting hæmatoma. The edges of the skin are finally approximated by a running chromic catgut stitch and the usual protective dressing applied. ("Clips" are used by some operators, but they interfere with the dressings and increase discomfort.)

*Drainage*—Before closing the incision, if drainage is necessary, it should be made as a rule by a stab incision well over to the right, its best location being determined by a couple of fingers on the inside. The skin is incised for about one inch and a pair of scissors thrust through and opened. A hæmostat passed alongside the scissors withdraws the ends of any ligatures which have been used and which have been purposely left long, and then withdraws the drain, the distal end of this drain being placed in the infected pocket from which the appendix has been withdrawn, but not in such contact with the stump of the appendix as to increase the danger of necrosis, if the infection extends into the pelvis, the drain should be carried down to the bottom of the pelvis, but great care should be taken to so place it that, if possible, as is almost invariably the case, it is not in contact with the small intestines, but is protected by the ascending colon, the cæcum, or perhaps the sigmoid, or by the omentum pulled down and if necessary held in place by a catgut stitch. In this way post-operative adhesions will be avoided and post-operative ileus. Sufficient drainage can almost always be secured by a single cigaret drain, passed to the bottom of the pelvis if necessary, but in rare cases a soft rubber tube wrapped in gauze and with a wisp of gauze on the inside is preferable. Great care should be taken that there is no pressure upon the intestine from such a drain, since pressure interferes with the blood supply and may precipitate necrosis. (In neglected cases with extensive involvement of everything, wide drainage may be the only salvation of the patient, who must then run the risk of post-operative hernia, fecal fistula and intestinal obstruction.) With such a drain in place, to be removed usually in two or three days or at the end of a week as the surgeon deems wise, the main incision can be closed completely and the danger of hernia thus minimized. If the sides of the main incision have been contaminated by contact with the gangrenous appendix or by discharge from the inside, the application of dilute tincture of iodine to the incision, after closing the

peritoneum and transversalis fascia to protect the abdominal cavity, will diminish the risk of local post-operative infection

Suprapubic drainage should be avoided if at all possible, since the small intestine will almost inevitably come in contact with the drain and form undesirable adhesions. Almost invariably the pelvis can be drained through a stab incision far over to the right as previously suggested

An objection has been offered to the ligature method that the ligature may be "blown off" by accumulation of gas in the bowel. I have never had such an accident, and I note that Horsley,<sup>3</sup> in discussing the matter, ridicules the suggestion, stating that it is "much less likely to happen on the stump of the appendix than on a blood-vessel. The stump of the appendix is soft and succulent tissue and the ligature sinks in well. Intracæcal pressure never even approximates the blood-pressure, so that if any surgeon is capable of ligating a large blood-vessel he should surely be able successfully to tie the stump of the appendix." In support of this statement by Horsley is the personal communication by Doctor Seelig that on several occasions he had taken at autopsy a fresh colon, ligated the appendix as in an appendectomy and then applied pressure with a force pump, with the uniform result that the colon always burst at its thinnest point but "there never was any strain on the ligature around the appendix." It would seem self-evident, however, that a ligature tied into the *crushed*, and hence devitalized and infected, base of the appendix, as by the technic of some operators, might readily result in disaster, especially when buried in an incubation chamber by the purse-string suture

As years have gone by I have in a good many cases had to re-open the abdomen for ovarian tumor, fibroids, gall-stones, *etc.*, in patients from whom I had previously removed the appendix. I have always made it a point to examine the field of my former operation, but in no instance have I found more than the slightest of adhesions, if any, and have never had a single case in which resulting adhesions had produced ileus or, indeed, any noticeable complication whatever. *This absence of adhesions has been in marked contrast to what was almost invariably found in cases in which at the previous operation the purse-string had been used*

In 1904, Major G. Seelig,<sup>14</sup> of St. Louis, published an article condemning the purse-string operation and urging upon surgeons the advantages of the much simpler procedure. Other prominent surgeons have practiced and urged the procedure described by him, but investigations seem to show that for some reason, perhaps the *vis inertiae* of egoism, the more complicated operation is still widely practiced notwithstanding its evident large morbidity and mortality

Aside from legislative requirements and improved technic, as suggested herein, satisfactory appendicitis statistics cannot be hoped for until we secure earlier operations through earlier diagnosis, perhaps along the lines suggested by Bastianelli,<sup>15</sup> who, about ten years ago, put his "creed" into three aphorisms "(a) When physicians are discussing whether the case is ap-



pendicitis or not it is (b) When they are inclined to admit the possibility of appendicitis without being perfectly sure of it it not only is, but it is about to perforate (c) When the diagnosis is sure, there is already perforation, with a more or less circumscribed peritonitis "

The advantages of the simple ligation treatment are (1) A minimum of time, (2) a minimum of manipulation of the cæcum, (3) no penetration of bowel, with its 88 per cent of infection (Roeder), (4) no possibility of a hæmatoma, (5) no possibility of devitalizing the wall of the cæcum, (7) an absolute minimum of fæcal fistula, (8) no incubation chamber for the encouragement of abscess

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# CONGENITAL UNILATERAL RENAL AGENESIA \*

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CONGENITAL unilateral renal agenesis may be defined as the congenital absence of one kidney. For a case to fit this definition, the other kidney must be composed only of elements derived embryologically from one renal bud. Aristotle was the first to describe this anomaly, according to Fortune. Consiliorum, in 1609, wrote the first description which has been preserved. Writers in former days paid slight attention to the clinical significance of this condition, because they believed it to be rare, and because it was often found only accidentally at necropsy of an elderly person who had died of a disease unrelated to the genito-urinary system. Thus, earlier accounts were usually only anatomic descriptions in which little effort was made to include either valuable clinical data or a complete description of the pathologic processes found. With the advent of surgery, toward the end of the nineteenth century, not infrequently nephrectomy was done when the patient had only one kidney, with fatal results. This served to attract attention to this anomaly and to instigate considerable research. Within the last twenty years, with the perfecting of examination by cystoscope and other diagnostic urologic procedures, attention again has been focused on this condition, and comment has arisen as to the possibility that such an anomaly might make the subject more prone to various types of renal disease or might influence the prognosis in cases in which disease of the urinary tract is present.

I wish to record nine cases that were observed in the Section on Pathologic Anatomy of The Mayo Clinic, together with data reviewed from a study of cases recorded in the literature. I have been able to consult original reports of 572 true cases. Reports of 513 of these cases were found in the literature and cited by other authors before me (Table I). Reports of the remaining fifty-nine cases (Table II) have been found in the literature and cited by me only. Forty-nine references to probable cases are listed in a separate bibliography as possible additional examples, I have not included them because I could not obtain the original articles.

Malformations of the kidney may be divided into five groups (1) Marked secondary atrophy or destruction of one kidney, (2) various forms of renal fusion in which both kidneys are present and help to form the kidney which, on gross examination appears to be single, the "solitary kidney" of Rokitsansky belongs to this group, (3) hypoplasia of one kidney, in which the atrophic kidney is much smaller than the other kidney, but is still

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\* Work done in the Section on Pathologic Anatomy of the Mayo Clinic. Submitted for publication September 21, 1931.

TABLE I

*Reports of Cases Found in Literature by Other Reviewers Than the Author of This Paper*

Author	True cases	Year	Journal
Ballowitz	213	1895	Virchow's Arch f path Anat u Physiol, vol cxli, pp 309-390
Moore	10	1898	Jour Anat and Physiol, vol xxviii, pp 400-412 (April)
Anders	55	1910	Am Jour Med Sc, vol cxxxix, pp 313-327 (March)
Dorland	6	1911	Surg, Gynec, and Obst, vol xiii, pp 303-319 (September)
Braasch	6	1912	ANNALS OF SURGERY, vol lvi, pp 726-739 (November)
Kelly and Burnam	3	1914	New York, D Appleton and Co, 582 pp
Motzfeldt	15	1914	Beitr z path Anat u z allg Path, vol lx, pp 539-563
Gruber and Bing	13	1921	Ztschr f urol Chir, vol vii, pp 259-299
Eismayer	75	1923	Ztschr f urol Chir, vol xi, pp 191-220
Eisendrath	30	1924	ANNALS OF SURGERY, vol lxxix, pp 206-228 (February)
Goldstein	18	1925	Southern Med Jour, vol xviii, pp 750-757 (October)
Fortune	3	1927	Ann Int Med, vol 1, pp 377-399 (December)
MacKenzie and Hawthorne	1	1928	Surg, Gynec, and Obst, vol xlv, pp 42-51 (January)
♂ Campbell	10	1928	ANNALS OF SURGERY, vol lxxviii, pp 1039-1044 (December)
Thompson	33	1929	Guy's Hosp Rep, vol lxxix, pp 207-219 (April)
Hennessey	22	1929	Jour Urol, vol xxi, pp 193-204 (February)
Total	513		

functioning, (4) cases in which aplasia of varying degree has occurred, microscopic study of the remaining aplastic tissue reveals varying amounts of atypical renal tissue, and usually the aplastic kidney is of such rudimentary development that it contains no functional tissue by which body metabolism is aided, and (5) the rare, true, unilateral congenital agenesis, the "unsymmetrical kidney" of Rokitansky and earlier writers. In this last type, no tissue is present on one side that can be identified microscopically as renal parenchyma. It is with this group that this paper will deal.

Many earlier writers described undoubted cases of renal aplasia as cases of unsymmetric kidney, and as a consequence confused the entire subject. Other writers, in reporting so-called new examples, often described cases that had been previously reported and included in earlier series. Thus, numerous series were duplicated in part. I have made an effort to credit the proper author with cases listed by him for the first time or in listing references to other possible examples. Therefore, the number of true examples attributed to various authors will not agree with that of previous papers on this subject.

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TABLE II

*Reports of Cases Found in the Literature by Author of This Paper*

Author	True cases	Year	Journal
Ogle	1	1851	Tr Path Soc London, vol iii, pp 382-383 (December)
Barth	1	1853	Bull Soc anat de Par, vol xxviii, p 338
Hillier	1	1864	Tr Path Soc London, vol xv, pp 43-48 (February)
Hodge	7	1871	Proc Path Soc Philadelphia, vol iii, pp 172-173
Penrose	1	1889	Tr Path Soc London, vol ix, p 161 (May)
Formad	6	1889	Tr Assn Am Phys, vol iv, pp 345-378
Hodenpyl	1	1893	Med Rec, vol xlv, p 155 (July)
Pearce	1	1894	Tr Path Soc Philadelphia, vol xvii, pp 141-142 (May)
Lambert	1	1895	Med Rec, vol xlviii, p 169 (August)
Chretien	1	1895	Bull Soc anat de Par, vol lxx, pp 660-661 (November)
Bourneville and Tissier	1	1896	Bull Soc anat de Par, vol lxxi, pp 49-95 (January)
Sankott	1	1897	Deutsch Arch f klin Med, vol liii, pp 463-474 (June)
Schultze	1	1899	Proc New York Path Soc, pp 282-283
Power	1	1900	Lancet, vol i, pp 25-26 (January)
* Deaver	1	1902	ANNALS OF SURGERY, vol xxvii, p 94
Schloffer	1	1906	Wien klin Wchnschr, vol i, pp 1515-1519
Viannay and Cotte	1	1906	Lyon méd, vol cvi, p 516 (March)
Bacharach	1	1909	Ztschr f Urol, vol iii, pp 921-926
Brunzel	1	1912	Ztschr f Chir, vol cxix, pp 170-188 (September)
Nemenoff	1	1912	Jour d'urol, vol i, pp 439-440 (March)
Adrian	1	1913	Folia urolog, vol viii, pp 95-130 (October)
Judd and Harrington	2	1919	Surg, Gynec, and Obst, vol xxviii, pp 446-451 (May)
Brack	1	1921	Ztschr f Urol, vol xv, pp 389-392
Leroux and Cornil	1	1921	Bull et mém Soc Anat de Par, vol xc, pp 234-235 (April)
Hannay and Young	2	1924	Brit Jour Surg, vol xi, pp 780-781
Huffman	1	1924	Jour Urol, vol xii, pp 379-382 (October)
Sheldon	1	1925	California and West Med, vol xliii, pp 1569-1571 (December)
Hensel	1	1925	Deutsch med Wchnschr, vol li, pp 1034-1035 (June)
Petersen	1	1927	Jour Am Med Assn, vol lxxxix, p 1778 (November)
Roberts	1	1928	Am Jour Surg, vol iv, pp 221-222 (February)
Gottlieb	1	1928	Ztschr f Urol, vol xlii, pp 97-102
Ceccarelli	1	1928	Jour d'urol, vol xxvi, pp 334-341 (October)
Walter and Krasnoselsky	1	1928	Ztschr f urol Chir, vol xxv, pp 424-441
von Gelderen	2	1928	Beitr z path Anat u z allg Path, vol lxxxii, pp 213-220 (November)
de Massary and Flandrum	1	1928	Bull et mém Soc méd d hôp de Par, vol lii, pp 1207-1209
Bratrud	1	1929	Minnesota Med, vol xii, pp 220-222 (April)

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Author	True cases	Year	Journal
Hewins	2	1929	Urol and Cutan Rev, vol xxxiii, pp 92-97 (February)
Adams	1	1929	New England Jour Med, vol cc, p 1037 (May)
Sharman	1	1929	Lancet, vol ii, pp 63-64 (July)
Pearlman	2	1929	Am Jour Surg, vol vii, pp 836-839 (December)
Fey	1	1930	Jour d'urol, vol xxix, pp 66-71 (January)
Carson	1	1930	Wisconsin Med Jour, vol xxix, pp 154-156 (March)
Ewell	1	1931	Wisconsin Med Jour, vol xxx, pp 92-95 (February)
Total	—	59	

Data derived from the reports in the literature as well as from study of the nine cases seen in The Mayo Clinic can be summarized as follows

The total number of cases of renal agenesis was 581

The incidence was 367 in 337,488 cases in which necropsy was performed, or one in 920 post-mortem examinations

There were 281 males (48.36 per cent) and 231 females (39.75 per cent). The sex was not stated in sixty-nine cases (11.87 per cent)

The left kidney was absent in 318 cases (54.73 per cent), the right, in 238 cases (40.96 per cent). Which kidney was absent was not stated in twenty-five cases (4.31 per cent)

The age incidence was as follows: more than twenty-one years, 381 cases, between the ages of two and twenty-one years, seventy-six cases, between birth and the age of two years, thirty-eight cases, foetuses, twenty-three cases, and age not stated, sixty-three cases. The average age of male adults was forty-four and four-tenths years, and of adult females, thirty-six and six-tenths years. The average age of the males who were between the ages of two and twenty-one years was eleven and six-tenths years, and of the females, fourteen and four-tenths years. The oldest man was aged eighty-eight years, and the oldest woman, seventy-six years

The kidney was smaller than normal in twenty-seven cases (4.64 per cent), normal, in thirty-one cases (5.33 per cent), enlarged, in 308 cases (53 per cent), and the size was not stated in 215 cases (37 per cent). The exact average measurements in forty cases were 13.3 by 6.6 by 4.5 centimetres (normal, 10 by 6 by 3.5 centimetres). The average weight in eighty-seven cases was 279.63 grams (normal, 150 grams)

The ureter was absent on the side on which the kidney was absent in 297 cases (51.11 per cent), of these, the left kidney was absent in 182 and the right in 115 cases

Kidney, ureter and renal vessels all were absent in 116 cases (19.96 per cent)

On the side on which the kidney was absent the ureter and the renal vessels were absent in nineteen cases (3.27 per cent)

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The ureteral orifice in the bladder was absent on the side on which the kidney was absent in 133 cases (22.89 per cent)

One ureteral orifice and the corresponding part of the vesical trigone were absent in forty-four cases (7.57 per cent)

The ureter on the affected side was obliterated, remaining as a cord of connective tissue in eleven cases (1.88 per cent) It was obliterated in the cephalic portion only in twenty-three cases (3.95 per cent)

The ureter was completely patent in eight cases (1.37 per cent)

The site of the absent ureteral vesical orifice was replaced by a diverticulum of the bladder in five cases (0.86 per cent) The ureter of the solitary kidney emptied into the opposite ureteral orifice in three cases (0.51 per cent) There were two patent ureteral vesical orifices in twenty-one cases (3.61 per cent) There were two patent ureteral vesical orifices from the solitary kidney in four cases (0.68 per cent) The ureter from the solitary kidney was duplicated in four cases (0.68 per cent) The ureteral vesical orifice was in the median line of the bladder in eight cases (1.37 per cent) The ureter opened into the seminal vesicle on the side of the absent kidney in sixteen cases (2.75 per cent)

The condition of the solitary kidney was as follows: normal, in 281 cases (48.36 per cent), diseased, in 179 cases (30.80 per cent), and not stated, in 121 cases (20.82 per cent)

Death was from diseases unrelated to the genito-urinary tract in 400 cases (68.84 per cent), from diseases of the kidney and ureter in 110 cases (18.93 per cent), and the cause of death was not stated in seventeen cases (2.92 per cent) When the reports were made, fifty-four patients (9.29 per cent) were alive Death of those who succumbed to diseases of the solitary kidney and ureter was caused by nephrolithiasis in twenty-four cases, from ureterolithiasis in sixteen cases, from chronic nephritis in twelve cases, from pyelonephritis and pyonephritis in twenty-seven cases, from renal tuberculosis in four cases, from hydronephrosis in eleven cases, from infarction in one case, from carcinoma of the kidney in one case, and from nephrectomy in twelve cases The solitary kidney was mistakenly removed for ectopic kidney in four cases, for pyelonephritis in three cases, for hydronephrosis with infection in two cases, for traumatic rupture in two cases, and the condition for which the kidney was not removed was not stated in one case

Congenital agenesis of one kidney was recognized by cystoscopic examination, urography, and so forth, in forty-one cases (7.05 per cent), at a preceding operation, in eighty-three cases (28 per cent), at necropsy, in 439 cases (75.55 per cent) and how it was recognized was not stated in eighteen cases (3.09 per cent)

The suprarenal gland was absent on the side on which the kidney was absent in sixty-six cases (11.34 per cent), in twenty-eight of these the right side was affected, and in thirty-eight, the left The suprarenal glands were atrophied on the side on which the kidney was absent in four cases (0.68 per cent), they were hypertrophied in thirteen cases (2.23 per cent), nor-

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TABLE III

*List of Congenital Anomalies Mentioned in the Literature as Being Associated in Cases of Renal Agenesis*

Anomalies unrelated to kidney	Cases	Anomalies unrelated to kidney	Cases
Uterus bicornis	51	Absent testis, seminal vesicles, vas de-	
Uterus unicornis	60	ferens and ejaculatory duct	4
Uterus didelphys	4	Absent vas deferens and seminal ves-	
Uterus bilocularis	2	icle	14
Uterus subseptus	1	Incomplete male genitalia	1
Uterus duplex with vaginal septum	4	Absent ejaculatory duct	1
Uterus bifidus	1	Atresia of anus and urethra	1
Malformation of the uterus	1	Atresia of anus with hypospadias	1
Absent uterus and vagina	11	Atresia of anus	3
Rudimentary uterus, tubes, ovaries	4	Absent anus, rectum, urethra	1
Defects of tube	1	Absent rectum	2
Only fimbriated end of tube	12	Malformation of rectum	1
Absent tubes, ovaries, ligaments	10	Atresia of œsophagus	1
Absent round ligaments	3	Talipes equinovarus	3
Atrophic ovary and cervix	5	Cleft palate	4
Atrophic tube	2	Harelip	5
Absent vagina	1	Meningomyelocele	3
Abnormal insertion of tube	1	Hydrocephalus	5
Malposition of ovaries	8	Microphthalmus	1
Undescended ovaries	5	Hemicephalus	1
Vagina with one side only	1	Anencephalus	1
Absent female internal genitalia	8	Absent patella, defect in occipital bone	1
Dermoid cysts of ovary	2	Idiocy	3
Dermoid cyst of tube	1	Malformation of liver	2
Tube inserted into vagina	3	Malformation of duodenum	1
Atresia of anus and vagina	2	Right lung with four lobes	1
Atresia of vagina with no labia minora	2	One eye absent	1
Stenosis of cervix of uterus	1	Absent nose	1
No external female genitalia	1	Ascending colon with a mesocolon	2
Atresia of hymen	2	Rectosigmoid crossing over to right	
Atrophic broad ligaments	1	side of pelvis	2
Tubal pregnancy	2	Congenital, complete, indirect inguinal	
Situs viscerum inversus	1	hernia	4
Ectopia of bladder	4	Fœtus with no umbilical artery	1
Absent bladder	1	Total	338
Atrophy of testicle, seminal vesicles		(58.2 per cent of 581 cases)	
and vas deferens	16	Anomalies of renal blood supply	Cases
Atrophy of vas deferens, seminal ves-		Abnormal origin of renal arteries	55
icles and epididymis	10	Abnormal emptying of renal vein	49
Atrophy of testis only	6	Multiple renal arteries	39
Atrophy of one lobe of prostate gland	3	Total	143
Cysts of seminal vesicles	8	(24.6 per cent of 581 cases)	
Undescended testis	4		

mal in 129 cases (22.20 per cent), and their condition was not stated in 369 cases (63.50 per cent)

A list of associated congenital anomalies is given in Table III. In order clearly to understand the mechanism of their occurrence, the embryologic

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development of the kidneys and genitalia of both sexes must be reviewed briefly

In human beings three sets of excretory organs develop in embryonic life. The first, or pronephros, is of importance only in that it furnishes the ducts of the second organ, or mesonephros. Aside from this, the pronephros disappears entirely. The mesonephros, or Wolffian body, gives origin in the male, from caudad to cephalad, to the following structures: seminal vesicles, ejaculatory ducts, vas deferens, and efferent tubules of the testes. Two Mullerian ducts arise about the same time, and in the female, their cephalic, divided portions give rise to the Fallopian tubes, whereas their fused, caudad portions form the uterus and vagina. The Mullerian ducts in the male form no important structure. The testes or ovaries arise separately from the adjacent genital ridge. The ureters arise as buds from the caudal ends of the Wolffian ducts, near the cloaca. The third organ, or metanephros, arises as a bud from the preexisting mesonephros. The adult kidney develops from this third structure. The suprarenal glands are not intimately connected with this development, and hence are rarely absent even if the kidney and other related unilateral structures are absent. Four theories have been advanced by Fortune as to the causation of this anomaly: (1) The metanephric bud may fail to appear in spite of a normally preceding mesonephros, (2) the metanephros may appear, but may undergo early regression, (3) the mesonephros may be imperfectly developed, and (4) the pronephros may fail to develop, and therefore the mesonephros does not grow. The greater incidence of malformation of the genitalia in the female associated with congenital unilateral renal agenesis can now be understood, because the Mullerian duct is a later development than the Wolffian duct, and as a consequence its chance of undergoing malformation is greater. In females the commonest malformations are those of the caudal portions of the Mullerian ducts, or the uterus and vagina, whereas the cephalic portions, or Fallopian tubes, are usually less involved. In the male the most advanced malformations of the genitalia occur about the bladder, and commonly diminish toward the testes. This fact supports the theory that a disturbance in the caudal portion of the embryo, involving the Wolffian duct, explains these anomalies. Associated malformations of the body outside the genito-urinary tract, although they may occur and may be extensive, are not common. From data obtained in the literature, it appears that in 58 per cent of 581 examples of renal agenesis there were associated anomalies of varying degree. Associated malformations were present in 89 per cent of the females and in 41 per cent of the males. Usually the associated defects of the genitalia are so slight that they do not cause comment on general examination, and as a consequence the presence of only one kidney is not suspected at the time of general examination.

The fact that in 381 cases (65.5 per cent) of congenital unilateral renal agenesis reported in the literature adults were affected, and that their average age was about forty years, together with the fact that 68.3 per cent of the



patients died of diseases totally unrelated to the genito-urinary system, indicates that the condition is not a serious menace to life. On the other hand, it must be remembered that these subjects offer poorer prognosis when disease of the genito-urinary tract is present. The patients do not tolerate extensive operations on the urinary tract, and hence the most conservative procedure compatible with arresting the disease must be instituted. With the excellent diagnostic procedures now available, the diagnosis of this

anomaly in the genito-urinary system is not difficult. However, it must be remembered that two patent ureteral orifices do not necessarily rule out the possibility of unilateral absence of a kidney. Twenty-five examples have been collected from the literature in which two patent ureteral vesical orifices were present, associated either with double ureter of a solitary kidney or with patent ureter on the side on which one kidney was absent.

Nine cases of congenital unilateral renal agenesis were found in the course of 6,349 post-mortem examinations done at The Mayo Clinic, or an incidence of one to 705. The cases are reported briefly.

#### SUMMARY OF NINE CASES SEEN IN THE CLINIC

**CASE I**—A woman, aged thirty-three years, died of generalized sepsis. The right kidney, its vessels, and ureter were absent. The right suprarenal gland, and the right ovary and tube were also absent. The left kidney weighed 310 grams and measured

FIG 1—Case IV. The solitary right kidney with ureter and bladder.

14 by 7 by 4 centimetres. Grossly, the left kidney was studded with milium abscesses which on microscopic examination were revealed to be of pyæmic, staphylococcal origin.

**CASE II**—A man, aged thirty-seven years, died of a disease totally unrelated to anomaly of the kidney. Only the left kidney was absent. The ureter and vessels remained as cords of connective tissue. Both suprarenal glands were present. The genitalia were normal. The right kidney weighed 362 grams and measured 14 by 7 by 5.5 centimetres, otherwise it was normal on gross and microscopic examination.

**CASE III**—A foetus, male, weighed 2,800 grams. The left kidney and ureter were absent. Both suprarenal glands were present. The genitalia were normal. The right kidney weighed 16 grams and appeared normal both grossly and microscopically.

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CASE IV—A man, aged fifty-four years, died of syphilis of the central nervous system and acute pyelonephritis. The left kidney, the ureter, and vessels were absent. Both suprarenal glands were present and the genitalia appeared to be normal. The right kidney weighed 320 grams and measured 13.5 by 7.5 by 5 centimetres. Marked pyelonephritis was present on both gross and microscopic examination (Fig 1).

CASE V—A female infant weighed 2,716 grams. The left kidney was absent. Both suprarenal glands were present. There was a uterus unicornis, absence of the right patella, bilateral talipes equinovarus, moderate hydrocephalus, slight meningomyelocele, and a left diaphragmatic hernia. The right kidney weighed 12 grams and appeared normal on both gross and microscopic examination.



FIG 2—Case VII. The enlarged solitary right kidney compared to a normal kidney from another patient.

CASE VI—A woman, aged thirty-three years, died of a disease totally unrelated to the kidney. The left kidney was absent but its ureter and vessels were present. Both suprarenal glands were present. The right tube was inserted on the uterus in an abnormal manner. The right kidney weighed 200 grams and measured 12 by 6 by 4.5 centimetres. It appeared normal both on gross and microscopic examination.

CASE VII—A man, aged fifty-six years, died of a disease totally unrelated to the urinary tract. The left kidney, its vessels and ureter were absent. Both suprarenal glands were present. The right kidney weighed 505 grams (normal, 150 grams), and measured 15 by 8 by 6.5 centimetres. It appeared normal both grossly and microscopically (Fig 2).

CASE VIII—A man, aged fifty-five years, died of a disease totally unrelated to the urinary tract. The left kidney, its ureter and vessels were absent. Both suprarenal glands were present. The left testis was moderately atrophied. The right kidney weighed 270 grams and measured 12 by 7.5 by 5 centimetres, otherwise it appeared normal both grossly and microscopically (Fig 3)

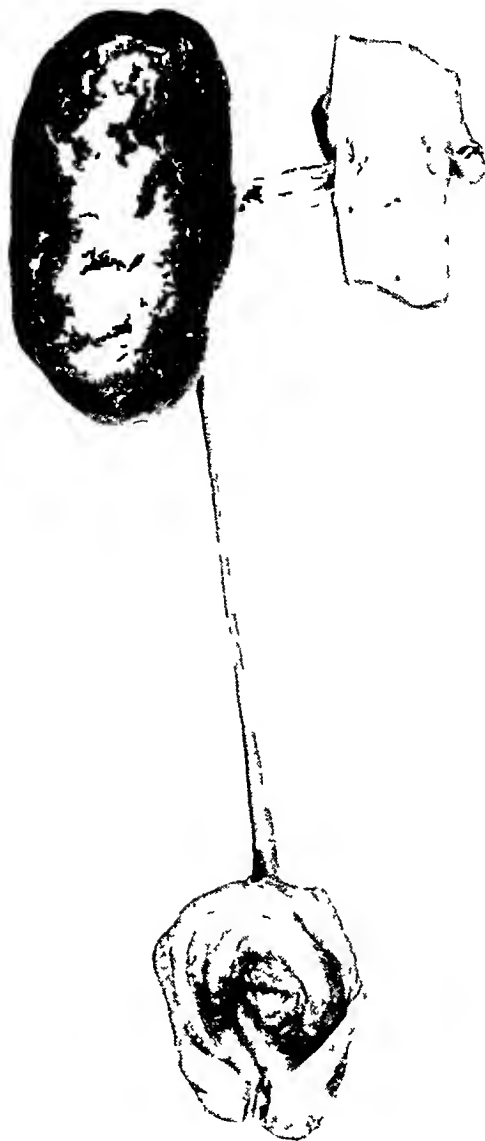


FIG 3—Case VIII. The right kidney, its ureter, renal vessels arising from the aorta, and the bladder. The absence of a corresponding left renal artery arising from the aorta, the poorly developed left portion of the vesical trigone, and absence of the left ureteral vesical orifice may be noted.

CASE IX—A boy, aged two years, died of hydronephrosis with infection and subsequent uræmia. The left kidney, its ureter and vessels were absent. One renal vein was represented by a cord of connective tissue. Both suprarenal glands were present. The right testis was undescended. The right kidney weighed 36 grams and measured 6 by 3 by 2.5 centimetres. On gross and microscopic examination there was seen to be advanced staphylococcic pyelonephritis as well as the marked hydronephrosis with infection.

# CONGENITAL RENAL AGENESIA

## SUMMARY

The literature concerning congenital unilateral renal agenesis has been reviewed, and reports of 572 cases have been found, fifty-nine of which have not been cited by any reviewer before me. Reports of nine cases seen at the clinic are given for the first time. Thus, 581 cases are considered in the paper. References to forty-nine questionable cases have been appended in a separate bibliography, these have not been verified, and are not included in the textual or tabular consideration.

## APPENDIX

### *Bibliography of Unverified Cases Found in the Literature*

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# THE INJECTION TREATMENT OF VARICOSE VEINS

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THE cases that form the basis for this report have been under treatment in the varicose vein clinic of the Fourth Surgical Division of Bellevue Hospital. The work was started in September, 1929, and has continued without interruption up to the present time. Up to September 1, 1931, 848 cases have been treated, with a total of 3,532 injections.

As to the various solutions used, together with the history attached to each, in 1923, K. Linser,<sup>1</sup> in Tubingen, first began the use of 20 per cent sodium chloride solution as a sclerosing agent in treating varicose veins. At about the same time, Sicard,<sup>2</sup> in France, was using 20 to 40 per cent sodium salicylate solution for the same purpose. It is really to the work of these two men that the modern treatment is indebted and from the time of their first reports the popularity of the treatment has risen by leaps and bounds. McPheeters,<sup>3</sup> in this country, was the first to become active in this line of work and his monograph on the subject is a very complete and lucid discourse on the treatment as he uses it today. Since McPheeters' original article appeared, numerous others by various authors have appeared, all agreeing as to the efficiency of the treatment and differing only in their choice of solutions and in certain minor details of the technic of administration.

Fifty per cent dextrose solution, a mixture of 50 per cent dextrose and 30 per cent sodium chloride,<sup>4</sup> and a mixture of quinine and urethane are the three other solutions that have been most extensively used, and these five may very properly be considered as the only ones worth discussing at present.

We have used all five of these solutions at various times with the idea of arriving, if possible, at the solution which to us gave the best results. The original solution that we used was a 20 per cent solution of sodium chloride on a group of eighty cases in doses of five to six cubic centimetres, 270 injections were given. Definite thrombosis occurred in 90 per cent of injections and failed to thrombose in 10 per cent. Following this, we used sodium salicylate solution in 30 to 40 per cent strength, the dose being four to five cubic centimetres at each injection. This was given for a total of 845 injections on a group of 250 cases. Definite thrombosis occurred in 95.5 per cent of injections and failed to thrombose only in 4.5 per cent. Fifty per cent dextrose and 30 per cent sodium chloride solution in doses of five to ten cubic centimetres was used next. Three hundred and forty-two injections

were given on 100 cases, with thrombosis in 92.1 per cent and no thrombosis in 7.9 per cent. Quinine and urethane was then used. The solution as we have given it is put up in ampules by various commercial firms and is readily obtainable. The dose is one-half to two cubic centimetres, depending upon the size of the vein, although our first dose is limited to one-half cubic centimetre to be sure of the patients' tolerance to quinine. Two thousand and seventy-five injections of quinine and urethane were given to 415 patients. Thrombosis occurred in 94.8 per cent of injections and no thrombosis in 5.2 per cent.

It will be seen from the above that the two solutions which gave the highest percentage of thromboses were the sodium salicylate and the quinine and urethane. The 30 to 40 per cent sodium salicylate solution has one distinct disadvantage and that is the very severe cramp-like, burning pain which occurs immediately upon injection and lasts for two or three minutes. This has been commented upon by various observers<sup>7</sup> and I for one have been very much impressed by the real severity of the pain. Patients will actually moan and cry out while it lasts and will describe it as the most acute and piercing pain they have ever had. In many instances, patients have refused a second injection of the salicylate solution because of the severe pain resulting from the first. On the other hand, the pain associated with the injection of the quinine and urethane is practically nil, and the percentage of positive thromboses is about as high as in the salicylate series. Because of this I have come to accept the quinine and urethane as the solution of choice for the injection treatment. There is no pain, the resulting thrombosis is always there and I have yet to observe any untoward reactions. A few more injections may be necessary than with the salicylate solution as the thrombosis may not be as extensive, but this is more than compensated for by the absence of the immediate local pain which is so severe in all instances.

The technic as followed by us is relatively simple. A stool is placed upon the examining table with the patient sitting upon the stool. This puts the legs in the pendent position, whereby the veins are distended and thus easiest to deal with. If the veins to be injected are in the thigh the patient is asked to stand upon the examining table and then is allowed to sit down at the conclusion of the injection. The site chosen for the injection is painted with a 3½ per cent tincture of iodine. The first injection is usually given in the lowest veins first, as it must be remembered that the blood flow in varicose veins of the dependent leg is in the reverse direction to normal and if the injection is given too high the resulting dilution of the sclerosing solution will be too great. This reverse flow of the blood has been very well shown by McPheeters by fluoroscopical studies following the injection of lipiodal into the vein. A short bevel twenty-five-gauge needle, extremely sharp, on a well-fitting two-cubic-centimetre Luer syringe completes the armamentarium. At the first injection, one-half cubic centimetre of quinine and urethane solution is injected and subsequently one to two cubic centimetres,

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depending upon the size of the vein to be injected. Injections are given once a week. Following the injection a small sterile compress is applied over the site of injection and firm pressure is made for two or three minutes to prevent leaking of the solution into the surrounding tissues through the needle hole in the wall of the vein. The compress is then held in place with two adhesive strips and the patient is told to remove it the following day. No tourniquets are used and no bandages are applied. We have tried them both and could not see that they aided the end-result in the least. Neither do we place the patient in a recumbent posture during the injection as some have advised so as to empty the vein and thus bring the sclerosing solution in more intimate contact with the vein wall. We tried this for a while and could see no improvement in our end-results. Following the injection the patient is assisted from the examining table and allowed to go home.

The most important point in the technic is in using care that none of the solution is injected outside of the vein. When the needle is first introduced into the vein, we advise withdrawing the barrel of the syringe a short distance so as to allow blood to flow back, thus assuring one that the needle is well in the vein. This is repeated when about half of the solution has been injected, as occasionally the needle point will penetrate the distal wall of the vein while the injection is taking place, unless care is used.

If some of the solution escapes into the perivascular tissues a slough may result. The amount of sloughing that occurs varies with the amount of solution that has escaped into the tissues and to a certain extent upon the individual patient. We have seen certain cases in which it was known at the time of the injection that some of the solution had been injected into the perivascular tissues and yet in these cases no slough occurred. A certain amount of redness and induration resulted but no real destruction of tissue. On the other hand, we have seen other patients where we also knew that a similar amount of solution was injected outside of the vein and a definite slough resulted. The size of the slough varies greatly and is a factor in determining the length of time it will take for complete healing to ensue. All sloughs are characterized by the relatively great length of time it takes for separation and healing to take place. It is not uncommon for some to take four or five months to heal. We do not feel that surgical excision is of any value, as we could not see any hastening of healing in the few that we so treated. We simply use a local wet dressing of boric acid at first, followed by boric ointment and then occasionally balsam of peru to stimulate granulations. Fortunately, in our experience, the sloughs have not been frequent, but in a large series of cases where a number of men have given the injections a certain number cannot be avoided. We do not look upon them with any feeling of anxiety, as they very seldom incapacitate the patient, and their principal disadvantage is the long time required for healing. Much has been said about some solutions being less likely to cause sloughs than others. With this we cannot agree. Our percentages of sloughs have been just the same whether the solution used was 20 per cent sodium chloride, 40



per cent sodium salicylate, quinine and urethane or a mixture of dextrose and sodium chloride. We cannot convince ourselves otherwise.<sup>6</sup> Any solution that is sclerotic enough in its action to cause a thrombosis in the vein will also chemically destroy other subcutaneous tissues if it comes in contact with them in sufficient amount. Fifty per cent dextrose we will admit does not come in this group, but on the other hand its sclerosing action is so definitely inferior to the other solutions that this in itself explains its lack of destructive effect upon the perivenous tissues.

Two or three days following the injection an area of redness and induration occasionally occurs in the vicinity of the vein injected. This sometimes is rather extensive and may become the cause of temporary disability. It is a periphlebitis due to the inflammatory reaction resulting from the chemical irritation of the vein wall, and is to be carefully differentiated from the slough. These areas of periphlebitis usually subside in two or three weeks spontaneously, and the comfort of the patient may be enhanced by local wet dressings of boric acid solution and rest of the affected limb. The percentage of periphlebitis following injection has been about the same with all of the solutions used. We are sure that it is as frequent with the quinine and urethane as with the others, although it has been suggested otherwise by some observers. The same rule applies here as with the sloughs, namely, that if the solution has a strong sclerotic action the likelihood of periphlebitic reaction is the same regardless of whether it happens to be sodium chloride, sodium salicylate or quinine and urethane. The condition, however, is never serious, it always subsides but it may be a cause of anxiety to the patient, due to the pain and disability resulting.

The most dramatic cases are those in which a varicose ulcer, frequently of long standing, exists. In this series there were ninety-four ulcer cases. Here the ulcer will frequently heal in a very short time. We have several cases where the ulcer had been present for over twenty years and where complete healing occurred within six weeks. The ulcer itself is entirely disregarded in the treatment, no special ointment is applied nor is any particular local treatment used. Usually Lassar's paste is our application of choice, but there is no particular rationale for this. It is used simply as a protective dressing. We feel that as the cause of the ulcer is entirely circulatory, it is rather superfluous to attempt local treatment. Our results have justified this viewpoint as we have been successful in healing about 90 per cent of the varicose ulcers that have come under our care. Those that have a coexistent brawny induration of the leg surrounding the ulcer have been confined in bed, either in the hospital or at home, for two or three weeks to allow the brawny area to soften and make it possible to find the veins therein. These veins can very often not be seen but must be found by palpation. Ulcers that have been healed have remained healed, at least as far as one can follow them in a hospital clinic.

The main point that we would like to emphasize is that the treatment should be technically simple and we have not found that any deviation from

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this rule has improved the results. A single injection with the patient upright, extreme care being taken to see that the needle is in the vein, is all that is necessary. If in doubt as to whether one is in the vein, do not inject, but select another vein. Then a simple gauze dressing and that is all. Local treatment of an ulcer is unimportant, as it is in the case of the slough. Simple cleanliness with antiseptic dressings is all that is necessary. The ulcer will heal if all the varicose veins are thrombosed and nature will separate the slough and healing by granulation will ensue.

In a recent article by De Takats,<sup>4</sup> he states that the salicylates and quinine are poorly tolerated by many patients. With this we cannot agree as in over 800 injections with salicylate, and over 2,000 injections with quinine we have seen only one constitutional reaction and that was one from quinine. In this case the patient became faint and pallid and then vomited, but was entirely normal again in about ten minutes and was able to return home. We have never seen any other reactions of any moment. We have used quinine and urethane routinely now for over one year and the absence of pain, together with the small amount of solution necessary and the excellent results obtained, cannot help but impress us that it is the solution of choice. The mixture of 50 per cent dextrose and 20 per cent sodium chloride solution<sup>8</sup> is undoubtedly of value but we have seen a number of failures with its use even when the various precautions suggested by McPheeters<sup>5</sup> were observed, and there is undoubtedly a definite pain associated with its use although not as severe as with the salicylate. We feel that an attempt has been made by some authors to make the injection method seem unduly technical. It is simple and should remain simple. There is no reason why any physician cannot use it with excellent results if he is careful in injecting and uses sharp needles and well-fitting syringes.

As far as the question of recurrences of the varicose veins is concerned not much has appeared in the literature. The results of Howard, Jackson and Mahon,<sup>9</sup> as reported in March, 1931, show an almost prohibitive percentage of recurrences. Our experience does not in any way bear out their findings. I have had an opportunity of seeing and following large numbers of these patients for the past three years and the number of recurrences that I see is exceedingly small. Practically all of the hospitals in New York City are using the injection method of treatment today and there are only a very few recurrences from other hospitals coming to our clinic. If the average percentage of recurrences were any way near as high as the above authors report, we would be flooded by cases with recurrences not only from our own clinic but from the other hospitals as well. We will admit that if one is not careful to thrombose the main internal saphenous trunk in the thigh, providing it is varicosed at all, recanalization of the veins in the leg below is more likely to occur. Frequently the fact that the internal saphenous vein is involved may be overlooked, as it occasionally will only be palpable when in the pendent position and not be visible at all. Careful search by palpa-

tion and inspection should be made for the main trunk of the internal saphenous vein and thrombosis obtained by injection

We do find that a certain number of varicose vein patients as such have a definite tendency to form other varicose veins later on. These new varicose veins, however, should not be confused with veins that have already been thrombosed. I have seen a number of cases such as this, where new varicose veins have appeared a year or so after the careful thrombosis of all existing veins. Careful examination and a follow-up at more frequent intervals will clearly show that the new varicose veins appearing are not recurrences but are new veins becoming varicosed due to the same tendency in the individual that was responsible for the formation of the first group of varicose veins.

The contra-indications to the treatment are, in main, two: (1) An active bacterial thrombophlebitis, and (2) any previous thrombosis of the deep veins of the extremity. Otherwise, we feel any case may be safely injected. Pregnancy is not a contra-indication except in the later months.

The accompanying chart is self-explanatory. It gives the number of injections with each solution, the percentage of thromboses resulting, together with the number of sloughs.

*Observations on 848 Patients with Varicose Veins Treated by the Injection Method*

	Total Injections	Good Thromboses	Percentage of Good Thromboses	Poor or Thromboses	Percentage No of Poor or Thromboses	Sloughs
Quinine and Urethane	2,075	1,969	94.8	106	5.2	24
30-40% Sodium Salicylate	845	807	95.5	38	4.5	11
20% Sodium Chloride	270	244	90	26	10	8
Dextrose and Sodium Chloride	342	315	92.1	27	7.9	3

Total number of ulcer cases treated—94

Total number of ulcer cases healed—84

Total number of ulcer cases not healed—10

Emboli—none

As I stated before, we are definitely of the opinion that in actual practice many of the refinements in the technic as advocated by some observers are not borne out. In theory, they are undoubtedly correct, but practically, we have not been impressed with their advantages. Whether the vein is collapsed or not at the time of injection has not altered the results. It would seem true that an intimate contact of the sclerosing solution with the vein wall would be enhanced by emptying the vein, but in practice over controlled cases I could not see any difference in the end-results. Tourniquets and bandaging we have discarded after a very thorough trial.

We have never seen a case of embolus following the injection treatment. This, at present, seems to be a universal finding and undoubtedly any embolic phenomenon can be practically ruled out as a possible complication of this method of treatment.

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## CONCLUSIONS

- (1) Eight hundred and forty-eight patients with a total of 3,532 injections are reported on
- (2) Quinine and urethane is our solution of choice because of the excellent results obtained, the small quantity of solution necessary, and the ease of administration with a small syringe
- (3) The technic of the treatment is simple and should remain simple. It should not be complicated by unnecessary refinements
- (4) In our experience recurrences are infrequent and should not be confused with the formation of other new varicose veins

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# SODIUM MORRHUATE AS A SCLEROSING AGENT IN THE TREATMENT OF VARICOSE VEINS

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ALTHOUGH the superiority of the injection method *versus* other forms of treatment of varicose veins is no longer an issue, there are several complicating features that have prohibited its being termed the ideal method. The chief points of dissatisfaction have been the following:

- (1) The pain or cramp resulting from venospasm at the time of injection
- (2) The destruction of tissues as a result of improper technic or extravasation
- (3) The toxicity and individual idiosyncrasy exhibited to the various drugs
- (4) Temporary disabling periphlebitis
- (5) Occasional failure to respond to treatment

We believe that the employment of the sodium-morrhuate solution in a large measure obviates all these difficulties, and we feel that there is now at our disposal a drug which more closely approaches the ideal than any other chemical sclerosing agent used for this purpose heretofore.

This paper is based upon a study of 200 cases and about 600 injections given with sodium morrhuate both in private and clinic practice. While the injection treatment of varicose veins is a safe procedure in experienced and careful hands, our observations lead us to believe that there is a higher mortality than that given in the literature, and that the mortalities are not due to pulmonary emboli but to infections contracted as a result of sloughs, and other complications resulting from poor technic and treatment of contraindicated cases. The technic and contraindications have been so well described in the medical literature in recent years by various writers that it is needless for us to repeat them. Notwithstanding the fact that the solutions used at present, such as sodium chloride, or sodium chloride in combination with glucose, dextrose, invert sugar, *etc.*, or sodium salicylate, or its sugar combinations, or quinine hydrochloride and urethane are strongly advocated by many, we are of the opinion that the ideal solution has not as yet been found.

An ideal solution would be one which would produce neither pain nor cramp following its injection, which would have no systemic action, and which would be least likely to produce a slough if injected outside the vein. And, above all, it must induce a firm, lasting and not painful obliteration of the injected vein. According to our experience sodium morrhuate is the closest approach to the ideal solution.

Sodium morrhuate was first made by Sir Leonard Rogers<sup>1</sup> for use in surgical tuberculosis. It was later produced by R. A. Cutting,<sup>2</sup> and he

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described the details of its preparation together with physical and chemical properties. The applicability of sodium morrhuate for varicose-veins treatment first occurred to P. B. Kittel, who administered a 3 per cent sodium-morrhuate solution intravenously for the treatment of surgical tuberculosis, and noticed that it frequently caused a hardening and occlusion of the injected vein.

Sodium morrhuate is a sodium salt of a fatty acid extracted from cod-liver oil. It is a yellow powder, which has a greasy, soap-like feel, and an odor that is characteristic of cod-liver oil. It is readily soluble in water and produces a clear, light amber-colored solution which foams on agitation. The substance in powder form deteriorates rapidly but is more stable when dissolved in water and sealed in air-tight containers. The preparations we used are a 5 per cent aqueous solution of sodium morrhuate to which 0.5 per cent phenol has been added as a preservative and one to which about 0.5 per cent benzyl alcohol has been added. The manufacturers of the latter claim that the benzyl alcohol acts as a preservative, as an anæsthetic and antispasmodic. We maintain that the benzyl alcohol does not produce anæsthesia, nor does it prevent cramp, and it is not necessary in this solution or in any other solution used in the injection treatment of varicose veins. Cutting states that it deteriorates and loses its therapeutic potency after a period of two weeks. Our experience does not verify his contention.

*Effects of Injections*—No systemic or toxic symptoms were observed, nor any immediate discomfort, pain or cramps noticed in any of our cases following the injection of sodium morrhuate. We have given at one sitting as high as ten cubic centimetres of the 5 per cent solution without any discomfort to the patient. This dose is extreme and is rarely ever indicated. The dose necessary to produce a sclerosing of the varix is proportional to the size of the vein. In small or medium-sized veins, one to two cubic centimetres of the 5 per cent solution are sufficient, in large veins, three to five cubic centimetres are necessary. While Kittel and Higgins<sup>3</sup> advise multiple injections at one sitting, we have seldom done so except in very small veins. We prefer to give single injections at twenty-four- or forty-eight-hour intervals, depending upon the response of the patient to the drug. As stated above, the injection produced neither pain, cramp nor any discomfort whatsoever. Occasionally, after a three to five cubic centimetre injection, some patients complained of a tingling sensation at the site of injection, but not of sufficient degree to cause any appreciable discomfort. A few minutes following the injection the vein begins to harden and this sclerosing extends below the site of injection for about two to four inches, depending upon the size of the vein and its response. About twenty-four hours later the vein is hard and firm and not very tender to touch, there being little or no periphlebitis, so commonly seen following the employment of other solutions. The skin about the injected vein assumes a light bronze color, which discoloration disappears in a short time.

Sodium morrhuate is not destructive to tissue. Kittel has injected 0.5

cubic centimetres of the 5 per cent solution into his own arm without any ill effects, other than a slight local tenderness. The similarity of the structure of the tunica vaginalis and the vein walls led one of the writers (Tunick) to inject sodium morrhuate into a hydrocele. (Courtesy of Dr Paul Aschner, Visiting Urologist to Hospital for Joint Diseases.) A fairly large hydrocele was tapped and then injected with two cubic centimetres of the 5 per cent solution. It did not produce any sloughing or destruction of tissues. There was a slight testicular tenderness which lasted about ten days. We believe this solution may prove of value in the treatment of hydroceles.

P McEvedy<sup>4</sup> has employed sodium morrhuate for obliteration of simple ganglia of the wrist, and he reports extremely satisfactory results. He employed 0.5 to 2 cubic centimetres of the 5 per cent solution and he has never seen any sloughing nor other damage to the tissues following its use. On Dr H. Finkelstein's service at the Hospital for Joint Diseases a series of ganglia and bursæ have been injected. Thus far, the cases injected show no evidence of tissue damage and the results appear promising. From these reports and observations we are led to conclude that the injection of sodium morrhuate will not produce a slough, should a perivenous infiltration occur. However, it is essential that the same precautions be observed in injecting the sodium-morrhuate solution as when employing a drug that will produce a slough.

*Technic of Injection*—Kittel and Higgins claim that the best results are obtainable when the injection is made into a fully distended vein, and they therefore inject the patient while in the upright position. Our own observations lead us to believe that a full distention of the vein is not necessary, not even preferable. The standing position may be of advantage in the smaller veins, but in the large veins it is advisable to elevate the limb to empty the vein of some of the blood, and then apply digital pressure or a tourniquet above the point of injection. Here pressure should be maintained for some two or three minutes after the injection so as to prevent dilution of the drug by the back flow of blood from above. Our results in injecting sodium morrhuate into the small veins, so-called spider bursts, or skyrocketers, have been better than those obtained with any other sclerosing solution.

In treating the smaller veins it is advisable to first immerse the ampule in warm water. This lowers its viscosity, and consequently permits the use of a finer-gauge needle. After the injection a small pledget of sterile gauze is applied over the vein puncture and is secured by a small strip of adhesive tape. Tight bandaging is not necessary. The needle puncture seals up rapidly. However, it is advisable to inspect the wound and see that there is no bleeding at the punctured site before the patient is permitted to leave. Patey's<sup>5</sup> experiments on rabbits have shown that an injection of one cubic centimetre of 5 per cent sodium morrhuate into the ear veins produces results similar to those obtained by the injection of 30 per cent sodium salicylate, *i.e.*, a general dilatation of the vessels of the ear, followed by the rapid for-

## SODIUM MORRHUATE FOR VARICOSE VEINS

mation of an intravenous clot Microscopically, degenerative changes can be detected in the vein wall, and an acute inflammatory reaction in the surrounding tissue He also found that sodium morrhuate was not so certain in thrombotic action as 30 per cent sodium salicylate, and that it definitely is not a blood coagulant

### CONCLUSIONS

(1) Sodium morrhuate does not produce cramp or pain following its injection

(2) It is apparently not destructive to tissues and therefore least likely to produce tissue necrosis or slough if injected outside the vein

(3) It produces a firm obliteration of the vein with very little periphlebitis

(4) It is not toxic

(5) The dose of it is one to five cubic centimetres of the 5 per cent solution, the average dose being two cubic centimetres

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# VARICOSE VEINS AND THEIR TREATMENT

WITH A STUDY OF THREE HUNDRED FIFTY-FOUR CASES

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THERE is still considerable skepticism as to the efficacy of the injection treatment, due primarily to the lack of understanding of the pathology of enlarged veins and the process which follows the injection of sclerosing solutions. It is to emphasize this phase of the subject that this paper is written. A series of 354 consecutive cases treated by the writer in the clinic of the First Surgical Division of the New York Hospital, service of Dr James M Hitzrot, will be the basis of the deductions made.

Pravaz, in 1851, was responsible for the introduction of the hypodermic syringe into Europe and the popularizing of its use. Following the injection of heavy metal solutions into veins he noticed that they thrombosed and could not be entered the second time. During the next half century sporadic efforts were made to obliterate enlarged veins by the injection of sclerosing solutions. The method, however, repeatedly fell into disuse. Only in the past twenty-five years has the measure received study and had extensive clinical verification as to its value. The pioneers in this field have been European surgeons, notably Sicard, of Paris, and Nobl, of Vienna. It is only within the last few years that the larger and well-known American clinics have accepted the injection of varicose veins as a sound therapeutic measure.

*Histology of Veins*—The normal vein wall presents a wide variation in structure, depending upon the site from which the section is taken. The inner lining of the saphenous vein wall, or intima, consists of endothelium. The chief variation is seen in the two outer coats, the media and adventitia. Lying just peripheral to the intima is a thin layer of connective tissue which contains a few elastic fibres. The media, or middle coat, is much thicker than the intima and consists largely of circularly arranged smooth muscle fibres and connective tissue. The adventitia, or outer coat, consists chiefly of connective tissue in which are seen fibres of elastic tissue circularly arranged. Smooth muscle has been described as being present in this part of the vein wall.

A section of vein taken from the lower tibial region presents a different picture from that described above. The smooth muscle in the media is arranged longitudinally instead of circularly and there is none present in the adventitia.

Varicose veins<sup>1, 2, 3</sup> present a picture of wide variation in the degree of degeneration of the vein wall. Some investigators are of the opinion that there is hypertrophy, and others that there is atrophy of the wall. The elastic fibres appear to be atrophied with a relative increase in the amount of connective tissue. The smooth muscle is atrophied in the more advanced cases.

## TREATMENT OF VARICOSE VEINS

In those cases of long duration the vein wall has the appearance of a thin membrane with the smooth muscle having the appearance of connective tissue. The intima in some cases is thickened, in others unaltered.

There is much confusion as to how œdema and ulceration of the tissues take place. Simple œdema is hardly sufficient reason for the presence of ulcer as there are many conditions accompanied by œdema which never produce ulcers. Consequently, another reason, perhaps associated with œdema, must be sought for. Hydrostatic pressure is not an underlying factor as studies have shown that the pressure in varicose and normal veins does not differ.<sup>4</sup> It seems most probable that ulceration results from inadequate nutrition of the tissues.

Where possible, one member of the body usually adapts itself to the increased work demanded of it when another member is devitalized or removed. It is logical, therefore, to assume that the communicating veins between the deep and superficial saphenous systems would enlarge sufficiently to carry the blood from the leg. This evidently does not take place. It then can be further stated that there is some interference with the return flow of these veins, assuming that they are patent, which has been shown to be the case in all uncomplicated cases of varicose veins.<sup>5</sup> What is this interference? It can only be the blood entering the communicating veins from some other source, and this source can only be the saphenous receiving blood from the common femoral vein and returning it to the deep system by way of the communicating veins, thereby interfering with the compensatory drainage of the leg. Recent studies tend to show that the blood volume in the leg with varicose veins is greater than that in the normal leg.<sup>6</sup> This theory is further substantiated by the rapid reduction of œdema and the subsequent healing of ulcers following the obliteration of varicose veins and the reestablishment of adequate nutrition to the tissues.

*Etiology*—The underlying cause of varicose veins still remains obscure. Certain contributing factors are well known and will be but briefly mentioned. The causes can be classified as direct and indirect. The direct causes are any condition or conditions which interfere or tend to interfere with the return flow of blood in the veins, *i e.*, the wearing of garters around the leg, long periods of standing on the feet, pregnancy and tumors of the pelvis in women, and transient periods of increased intra-abdominal pressure as in coughing, sneezing, *etc.* In some cases, there may be a low-grade inflammatory process resulting in the weakening of the valves and walls of the veins, but one or more of these conditions are operating in the majority of people more or less constantly and all do not develop varicose veins. It is therefore logical to assume an underlying factor upon which the direct causes are superimposed.

In this series of 354 cases, 56 per cent of the patients stated that some member of the family had suffered or was suffering from varicose veins. Sixteen per cent stated that some member of the family had "trouble with his legs" but they were not certain about the presence of varicose veins. One patient, observed over a period of many years, first developed varicocele

and now has varicose veins and, in the family, the mother and three sisters have varicose veins

Bier and Lehmann propounded the theory of inherent tissue weakness in and about the vein wall and in the valves. Our observations are more in accord with this idea. Whether or not there is an accompanying faulty endocrine activity is a much discussed question, but the theory has its advocates

Obstructive deep phlebitis resulting in compensatory dilatation of the external saphenous system has been seen by every physician and hardly enters into this discussion

*Selection of Cases*—It is very important to take good histories and examine patients presenting themselves for treatment. Those complaining of excruciating pains in the legs must be carefully studied for other conditions. Although varicose veins produce marked discomfort, it is not described as "excruciating." Endarteritis, thrombo-angitis obliterans, and Raynaud's disease are occasionally seen and should be treated accordingly. Patients with varicose veins who also have arthritis, weak feet or sciatica should be treated for these conditions as well as for the veins, but they should be cautioned not to expect much relief from their discomfort until the other conditions have been improved. It is important to differentiate ulcers due to syphilis, diabetes or those resulting from trophic disturbances, and to treat them accordingly. Patients with compensatory varicosities following obstructive deep phlebitis should not be treated until all evidence of the acute process has subsided. We arbitrarily advise a period of eight months as a minimum time limit before treatment is begun. When treatment is started it is carried out with the utmost caution and all presenting veins are not obliterated. Invertase 60 per cent, the mildest sclerosing solution, is used because it is the least irritating, the least penetrating and is adequate in its sclerosing action. In these cases one must always be aware of the possibility of causing an acute exacerbation of the old phlebitis. These patients can be very definitely helped, but during treatment it should be constantly kept in mind that the presenting circulation is compensatory.

*Choice of Solutions*—There is no one solution which satisfies all the requirements in every case. The patient as an individual should receive consideration, as well as the veins treated. The apprehensive and nervous patient will not tolerate the cramps accompanying the use of certain solutions. Furthermore, some veins sclerose more easily than others with exactly the same conditions operating. The size of the veins or their duration has little to do with their response to the solutions used. Consequently, one cannot limit himself to one solution and obtain consistently satisfactory results. Sodium salicylate in all concentrations is no longer used in this clinic. It is less efficacious when used routinely than some of the other solutions and the cramps which accompany its use destroy the morale of many patients. Occasionally, it is highly toxic and if any is injected into the

perivenous tissues a slough results which heals very slowly Sodium chloride is not used for the same reasons

We find that 5 per cent quinine and urea hydrochloride when used routinely yields the most satisfactory results Its chief disadvantage is that only small amounts can be used at a time 15 cubic centimetres usually, and occasionally as much as four cubic centimetres It is very toxic to many patients and this must be ascertained before it is used Uncommonly a sloughing ulcer will develop if any of the solution is injected outside the vein wall A chemical phlebitis occurs following its use more frequently than when other solutions are used The condition, when it occurs, is temporary and is treated with rest and cold boric acid compresses There is usually no elevation in temperature

A 50 per cent dextrose-30 per cent sodium chloride combination solution is best for the large veins because as much as fifteen cubic centimetres at a time may be used without any general effects to the patient It does, however, produce a rather severe cramp which lasts two or three minutes Invertase 60 per cent is the solution of choice for the small superficial type of vein and for those where there is some difficulty in entering the lumen If any of this solution should be injected outside the vein wall, it will result in no slough

*Technic*—The technic is very simple and requires no elaborate armamentarium Certain details, however, must be meticulously observed to avoid complications A tourniquet should be placed above the site of injection when it is made in the thigh because of the close proximity of the opening of the saphenous into the common femoral vein When injection is made below the knee a tourniquet is unnecessary The semi-sitting position is the position of choice for the patient A 25-gauge needle with a very short bevel is the most satisfactory to use After the vein is entered, which is indicated by a free flow of blood into the syringe, it is emptied as completely as possible by a pumping action of the free hand before injection is begun This serves to lessen the dilution of the solution used, thereby permitting more effective action on the vein wall While the injection is taking place, pressure is exerted above and below the site in order to localize the solution This can be done with the thumb and forefinger of the opposite hand This can also be accomplished by means of several different types of metal rings which have been invented for this purpose They are placed over about two inches of vein and held firmly by straps around the leg Others have projections upon which pressure can be exerted After the injection is completed pressure is exerted directly over the site by means of a cotton or gauze pledget The needle is then withdrawn and the pledget is held in place for about twenty-four hours by means of one-inch adhesive strips Injections are usually begun in the lowest part of the leg, gradually working upward Two injections a week can be given Strict asepsis is always observed When œdema is pronounced or when there is an accompanying complication of ulcer, the use of an elastic bandage is advisable

The technic, although described before with slight variations, is reiterated here to emphasize the importance of detail in this treatment. Sloughing ulcers are signs of lack of care and carelessness in inattention to detail.

*The Pathological Process Which Follows the Injection of Sclerosing Solutions*—The process has been fully studied by many investigators and it is the knowledge of their results which has been responsible for the confidence extant in the efficacy of this measure.

The constriction of the vein results in the slowing of the blood-stream and the presence of a foreign solution inimical to the blood elements results



FIG 1

FIG 1—Microscopical picture of a vein three months after injection with five cubic centimetres of 30 per cent sodium salicylate solution. No reaction in the vein wall and no organization taking place in the clot.

FIG 2—A section of vein wall removed one month after the injection of two cubic centimetres of 5 per cent quinine and urea hydrochloride showing the reaction which has taken place, with the growth of fibroblasts.



FIG 2

in clotting. The action of the solution causes a hæmorrhagic appearance of the intima followed in most cases by sloughing. Following this there is cellular infiltration of the vein wall. This varies, depending upon the degree of reaction taking place in the media and adventitia. With the beginning of the organization process fibroblasts grow from the vein wall into the clot. There is gradual formation of fibrous tissue and the clot is absorbed and the lumen obliterated. The result, after a few weeks, is a fibrous cord replacing the varicose vein. This requires sometimes several months before it entirely disappears.

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Fig 3A—

At the beginning of treatment patient has, in addition to other large veins, an area of phlebectasis ('bunchy' veins) below the left knee

Fig 3B

The same patient at the end of six months, the 'bunchy' veins have entirely disappeared

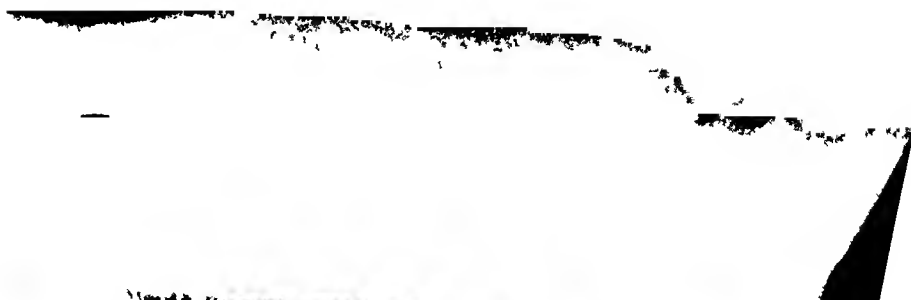
quinine and urea hydrochloride on two separate days accomplished this result

Now two and one half years later, no recurrences

Fig 3B

One injection of two cubic centimetres of 5 per cent

phlebectasis ('bunchy' veins) below the left knee



There are times when, apparently, no organization takes place. Fig 1 illustrates this point. The lumen of the vein is filled with the clot attached to one side of the wall. There is very little destruction of the intima and no reaction in the media or adventitia with no organization taking place. Before treatment the vein was one centimetre in diameter. It eventually disappeared and, after two years, shows no evidence of recurrence. Clinically, the results are excellent, theoretically, when this process follows injection, recurrences might be expected.

*Contraindications to Treatment*—Any case can be treated excepting those patients having any evidence of active disease. When a fair measure of health has been restored to them treatment can be started or resumed. There is no age limit. A great amount of comfort can be given to the aged as well as to the young. The youngest patient in this series is eighteen and the oldest seventy-nine years. Chronic diseases as they appear in elderly people are no contraindication provided there is a fair margin of health left. Those patients with inflammatory conditions about the legs should not be treated until all signs have entirely disappeared.

*Comment and Results*—Of the 354 cases treated by the writer, 127 discontinued treatment after improvement but before they were discharged as cured, 227 completed the treatment and were discharged as cured. Two of this latter number, or  $8 \frac{1}{2}$  of 1 per cent, returned within six months with recurrences. Ten of the entire series had been operated upon previously for varicose veins. Two of the ten had been operated upon twice for the same condition. This group alone shows a recurrence of over 4 per cent as compared to the above 8 per cent following the injection treatment.

Some surgeons advocate ligation of the large saphenous vein below Poupart's ligament followed by injection of the remaining veins. We feel that there is no advantage in this procedure as our results have been entirely satisfactory when the saphenous has been injected at its high point in the thigh. Actually, there should be less danger from the sclerosing clot which forms after injection than from an ordinary clot which forms when a vein is ligated.

Areas of phlebectasis or the "bunchy" type of veins are successfully treated by injection and do not require excision. Fig 2 illustrates one of these cases and the results after six months.

Complete cooperation of the patient is necessary to accomplish satisfactory results. When possible, two injections a week are advisable. The average number of injections per patient in this series was eleven and the greatest number given to one patient was fifty-one.

*Ulcers*—Fifteen per cent of our patients presented some form of ulcer. The majority have healed promptly following the obliteration of the large veins and the reestablishment of adequate nutrition to the tissues. A drying bland ointment is used on the ulcer and an elastic bandage is snugly applied when œdema is pronounced. The ulcers surrounded by "brawny" indurated areas heal much more slowly because the varicose veins are difficult to get at

## TREATMENT OF VARICOSE VEINS

and it is only when this is accomplished that they will heal. A few are so obstinate that only rest in bed accomplishes the desired results.

CONCLUSIONS —(1) A knowledge of the pathology is the basis for the confidence in the injection treatment of varicose veins and the high percentage of cures indicates its efficacy.

(2) No one solution satisfies all the requirements for the injection treatment, consequently several solutions must be at one's command in order to secure satisfactory results.

(3) Patients with any active disease should not be treated until the condition has entirely abated and several months have elapsed.

(4) Patients of all ages can be treated.

(5) Care and meticulous attention to detail will practically eliminate complications.

(6) The majority of ulcers heal rapidly following the obliteration of the varicose veins and the reestablishment of adequate nutrition to the tissues.

(7) If but one solution is available, the most satisfactory is 5 per cent urea hydrochloride and quinine.

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# VARICO-PHLEBITIS AND THE INJECTION TREATMENT

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THE safety and effectiveness of the injection treatment of varicose veins has been adequately demonstrated. Nevertheless, annoying and even serious complications still occur in any large series of cases, and the method is attended by a definite if minute mortality. In the frequently quoted series gathered from the literature by McPheeters and Rice,<sup>1</sup> there were seven deaths in 53,000 cases. Laqua,<sup>2</sup> in a careful review, has collected three further reports, and unquestionably many other fatalities have escaped publication. Nevertheless it may be assumed that the figures above demonstrate the essential safety of the method.

In a critical analysis of the injection treatment, from the point of view of its safety, two questions must be asked:

1. Is the method as safe as any other now available? The evidence at hand suggests a strongly affirmative answer.

2. How does the mortality and morbidity of injection therapy compare with the incidence of death and disability resulting from the varicose vein syndrome itself?

The great contribution of injection treatment is the relief of disability which it has made possible. On this score, it needs no apologies.

The question of mortality is a more difficult one to answer. That deaths from embolism, hæmorrhage, and perhaps indirectly as the result of ulceration can and do occur, is not to be doubted. However, while information on the subject is meagre, such figures as are available suggest the extreme rarity of such fatal accidents. Thus Kolisko<sup>3</sup> points out that in Vienna from 1900 to 1907 there were fifty-nine deaths from embolism, only four of which were traceable to varicosities. Such evidence would seem to indicate that the mortality from varicose veins and their complications is almost negligible. That being true, no mortality rate from the injection treatment, no matter how small, can be accepted with equanimity. It is a question whether an occasional death can be regarded as a fair price for the relief of disability and suffering conferred.

The safety of chemical obliteration lies in the early firm adherence, the rapid organization, and the localization of the thrombus produced by injection. Its dangers are to be sought in deviations from this optimum response.

In any extensive series of injections, one is impressed by the wide variation in the local effects produced in various individuals, or with successive injections in the same patient. Roughly, these responses may be fitted into the following diagrammatic scheme (Fig 1)

## VARICO-PHLEBITIS

The injection may be without effect (1) or the lumen of the injected vein may be obliterated by the agglutination of its endothelial lining, (2) neither vein nor thrombus being palpable at the site of injection several days later. In the third case, a localized thrombus appears near the injection site, palpable as a firm longitudinal mass extending for several centimetres along the course of the vein. This reaction (3) constitutes the ideal response to a single injection made with the technic routinely employed in this clinic. The remaining reactions depicted in the scheme represent deviations from this optimum effect. Thus a single injection may produce a surprisingly extensive occlusion, involving a whole group or system of veins (4). Such a reaction has most frequently been observed in the greater saphenous system—where an injection in the lower thigh or even below the knee may result in a thrombosis which sweeps unimpeded along the straight, widening channel of the greater

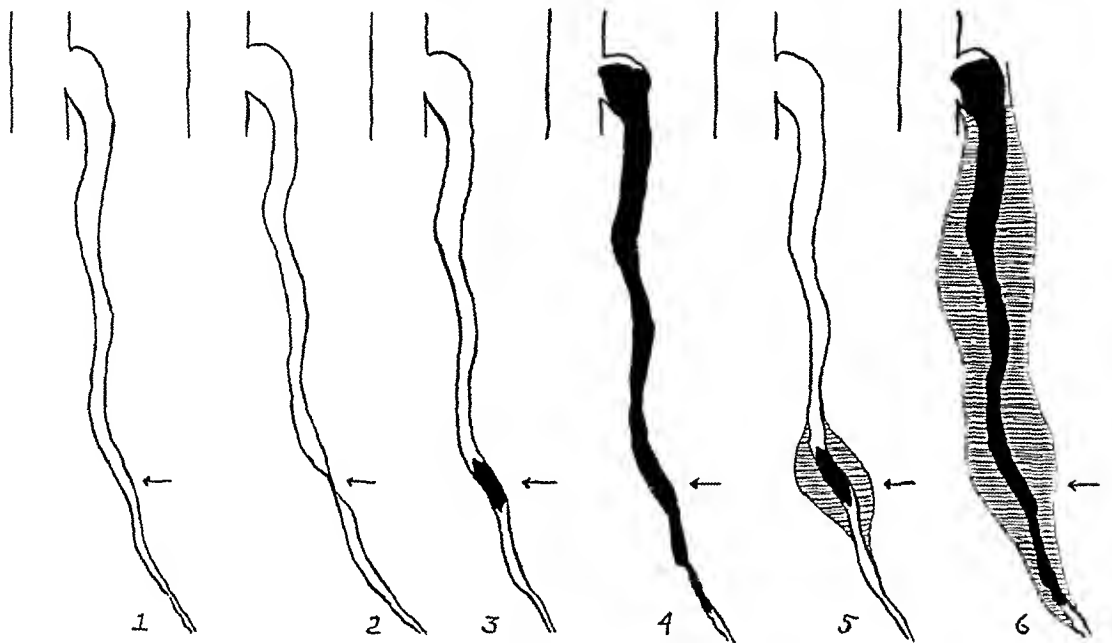


FIG. 1

saphenous stem in the thigh, stopping only at the opening of this vessel into the femoral vein at the saphenous opening. While this reaction inspires a sense of distrust, it does not differ qualitatively from the preceding type (3) and is not greatly feared. The thrombosis is in all probability a "chemical" one, and the dilution of the injection medium together with the volume and velocity of the venous flow in the femoral vein are safeguards against its further propagation into the great vessels above. The remaining two reactions depicted differ qualitatively from those thus far described. Reaction (5) represents an occlusion restricted to a relatively small extent of the injected vein, but in addition there appears within a short time after injection a perivenous reaction, accompanying the vein for the extent of the occlusion, varying from a slight induration, somewhat reddened and tender, to a massive, tender, painful red swelling, following the course of the obliterated vein. Such a reaction may also become extensive, involving, for example, the entire

saphenous system, extending along the saphenous stem, to stop menacingly at the saphenous opening (6) It is this type of response which carries with it the greatest danger of embolism and of an ascent to the major deep veins above, and is consequently viewed with the greatest concern

An analysis of the tables here presented, compiled chiefly from McPheeter's<sup>1</sup> and Laqua's<sup>2</sup> reports will demonstrate the genuineness of these

TABLE I  
*Ascending Thrombosis, Recovery*

Author	Solution	Ascend- ing throm- bosis	Embo- lism	Deep vein throm- bosis	Death	Remarks
Hirsch	Varicosmon	+	0	+	0	Common iliac thrombosis oedema of both legs
Lohr	20 per cent NaCl	+	0	+	0	Diagnosis of Vena Cava Throm- bosis
Redner	—	+	+	+	0	Diagnosis of bilateral femoral thrombosis, repeated embo- lism
Reimann	Glucose 50 per cent	+	+	+	0	Severe thrombophlebitis, re- peated embolism

TABLE II  
*Embolism, death, no ascending phlebitis noted*

Olson	NaCl and Calorose	0	+	0	+
McPheeters	NaCl 25 per cent	0	+	0	+

dangers In Table I are listed four cases of extension to the major veins which terminated favorably The eight fatal cases included in Tables II and III are only those in which death followed directly as a result of injection In two of these (Table II) fatal embolism occurred in the presence of a clinically normal local reaction to injection In four of the remaining cases,

TABLE III  
*Ascending phlebitis, embolism, death*

Author	Solution	Ascend- ing throm- bosis	Embo- lism	Deep vein throm- bosis	Death	Remarks
Hohlbaum	Pregl's Solu- tion	+	+	0	+	
Kausch	Pregl's Solu- tion	?	+	?	+	Full details not available
Kühnau	Calorose	+	+	0	+	
Lomholt	NaCl 20 per cent	+	+	0	+	
McPheeters	NaCl 20 per cent	+	+	+	+	"Entire leg swollen"
Levai	?	+	+	?	+	Septic thrombophlebitis Quoted by Vigyazo

death followed an ascending thrombosis with embolism In the fifth case, death occurred from a septic phlebitis, while information on the sixth is incomplete Thus in the total of seven cases (Tables II and III) in which death was directly attributable to injection, for which adequate data are available, four were the result of ascending progressive thrombophlebitis and

embolism, two, of embolism alone, without an obviously abnormal local reaction, and one, of a septic thrombophlebitis

The last two types of reaction (Figs 1, 5 and 6) have received considerable attention in the literature. Meisen<sup>4</sup> (1927) spoke of the occlusion accompanied by a vigorous perivenous reaction as a "chemical phlebitis," and this conception has been accepted by McPheeters,<sup>1</sup> Cattell<sup>5</sup> and others. Cattell<sup>5</sup> has called the extensive thrombosis with perivenitis (Figs 1-6) an ascending chemical phlebitis. McPheeters<sup>1</sup> on the other hand feels that all extensions from the local reaction which itself may be due "to a certain amount of fluid passing through the thin vein wall by osmosis," must be regarded as infectious in origin, the results of the lighting up of a latent phlebitis. This view is shared by de Takats.<sup>7</sup>

The writer agrees that some of the local reactions with periphlebitis are indeed chemical in origin. Nevertheless, there is reason to believe that here, too, the lesion is an infectious one in a large percentage of cases. Indeed, the line between so-called chemical phlebitis and a true infectious phlebitis following injection may be exceedingly difficult to draw. This point is illustrated by the following case.

CASE I—A woman of forty-six, in excellent general health presented herself at the Northwestern University clinic on July 23, 1930, with very large varicosities involving the entire extent of both greater saphenous systems. There was no history to suggest either a superficial or deep vein phlebitis. Because of the size and upward extent of the varices, a bilateral high ligation of both saphenous trunks was decided upon. Through a misunderstanding, while the patient was awaiting ligation, three injections of glucose and saline were made into the varices below the left knee. On August 22, 1930, the patient presented herself for ligation. Because of a red tender swelling which extended for about 7 centimetres along the course of a recently injected vein on the left, no ligation was done on this side. The usual ligation was done on the right. A week later she returned. The ligation wound was clean. A firm thrombus occupied the short proximal stump of the vein, but the distal segment was collapsed and empty. On the left side, however, a firm, reddened, tender mass had appeared in the course of the greater saphenous trunk in the thigh. A distance of at least 10 centimetres intervened between this swelling and the mass below the knee previously noted. While somewhat more extensive, the lesion in the thigh was scarcely to be differentiated in its general clinical characteristics from that below the knee. The patient's temperature was 99° F. Two weeks later an injection into the saphenous trunk on the right, several inches below the point of ligation, resulted in a lesion clinically identical with that which had appeared previously, first below and subsequently above the left knee.

Although the lesion appearing in the left thigh more than a week following injection could scarcely be interpreted as a "chemical phlebitis," it was clinically in all essentials similar to the reaction which had previously followed injection on the left side, and subsequently developed about an injection site below the point of ligation in the right saphenous trunk. To what may the marked reactions in this case have been due? We are becoming increasingly convinced of the essentially infectious nature of such lesions and our interest has consequently been aroused in the possibility of the existence of latent or "resting" infection in the walls of the affected varices. During

recent months, Dr A I Kendall<sup>6</sup> and the writer have succeeded in accumulating suggestive bacteriologic evidence in support of such a possibility. Furthermore, evidence of a clinical nature in favor of such a view is abundant. Thus spontaneous thrombophlebitic lesions, clinically similar in all respects to those just described, are seen with remarkable frequency in this clinic (Fig 2). More interesting still are the reactions occurring as the result of mechanical factors. De Takats has seen a marked involvement of this type



FIG 2—Large phlebitic patch occurring spontaneously in the varicose trunk of the left greater saphenous vein at the level of the knee joint

follow the simple aseptic puncture of a varicose vein. An even more striking demonstration is furnished by the massive thrombosis with periphlebitis which frequently occurs along the saphenous trunk distal to the point of a high ligation. This phenomenon, and other interesting evidences of the role of resting infection, are illustrated by the following two cases

CASE II—A woman of thirty-four came to the Northwestern Dispensary on November 18, 1930, for the relief of varicosities of sixteen years' standing. Examination revealed a very marked involvement of the right saphenous system extending to the saphenous opening, and a less marked involvement on the left, the moderately enlarged

## VARICO-PHLEBITIS

trunk of the saphenous being palpable on this side to the mid-thigh. A preliminary ligation was decided upon for the right side, injections for the left. On November 21, a high ligation of the right saphenous stem about two inches below its femoral opening was performed under local anaesthesia. On examination on November 25, 1930, the wound was perfectly clean. A firm, moderately tender, dull red induration had appeared the previous day on the medial aspect of the lower third of the leg just above the internal malleolus. This extended for about 10 centimetres along the course of the greater saphenous trunk which was thrombosed for a corresponding extent. The temperature was 99° F. On November 28, 1930, the process had extended almost to the level of the knee. On December 4, 1930, however, the process began to extend to the thigh, so that on December 5, 1930, there was a thrombophlebitis terminating about three inches below the site of ligation. There was no further extension, so that by December 19, 1930, the periphlebitis had almost subsided, the firmly thrombosed saphenous trunk being palpable as a firm cord running from the ankle to the point of ligation.

Here again the evidence points strongly to the existence of latent or resting infection, swept into activity by the trauma and stasis resulting from a simple ligation at some distance from the point of first appearance of the inflammatory process. It is to be emphasized that the post-ligation phlebitis presents all of those gross clinical characteristics described for the lesion appearing spontaneously and following injection or simple puncture.

CASE III—A fifty-six-year-old woman in good general health was first seen in the Northwestern University clinic on November 18, 1930. At the age of eight she had "typhoid fever." No details concerning this illness were available. As far as she knew there had been no trouble with either leg at that time. Four years previous to entrance she developed a painful swelling of the entire right leg and thigh, as a result of which she was bed-ridden for several weeks. There had been no return of the swelling. Two weeks ago a small tender patch appeared on the right leg—below the knee—and this persisted. On examination there was an ovoid thrombophlebitic patch involving a clump of varicosities below the right knee on the medial aspect of the right calf. Other varicosities were scattered over the calf. The deep veins, by the usual criteria, were patent. With a series of Unna's paste boots, the patch on the right subsided and on January 13, 1931, 5 cubic centimetres of a glucose saline solution were injected into a varicosity below the knee on the opposite (left) side. She was seen at her home several days later. The entire left saphenous trunk was thrombosed, with a tender, moderately red periphlebitic reaction. A firm, tender mass occupied the proximal end of the vein, high in the groin, at the saphenous opening. After several days of rest and elevation she was seen again. Her temperature was normal. A massive oedema had developed, however, involving the entire leg and thigh, and the greater saphenous trunk was still present as a tender, swollen induration. Three months later, the entire left greater saphenous stem remained firmly thrombosed, and there was a gradually decreasing oedema of the leg and thigh.

It is now felt that the history of a deep phlebitis four years previously on the right side, together with the presence of a recent superficial phlebitic patch, should have served as a warning of the possibility of trouble from any therapeutic manipulation which might be undertaken on the left in this case. That a phlebitic tendency may be bilateral is also demonstrated by Case I above.

It has been suggested above that the most important direct dangers of injection treatment arise in association with the thrombophlebitic reactions which may follow injection. The evidence here presented indicates the probable importance of resting infection as the background for such reactions.

The problem of preventing some of the most serious complications of this form of treatment is therefore intimately concerned with the problem of resting infection. The precautions which are to be taken to avoid the lighting up of such infection in the vein walls may be briefly indicated here.

In the first place, the importance of avoiding injection in the presence of definite patches of superficial phlebitis must again be stressed. Ample time—we are still often waiting several months—must be allowed for the subsidence of such processes. In the absence of frank lesions, the greatest caution must be observed where there has been a history of post-operative, post-puerperal, or post-infectious (typhoid, pneumonia) deep vein occlusion. Here the problem may present material difficulties. What specific means are available for the detection of resting infection in such cases? In other fields of surgery, fairly adequate methods for the detection of resting infection have been developed (Frund,<sup>8</sup> Kuntzen,<sup>9</sup> Payr<sup>10</sup>). The subject has been reviewed in detail by Payr in whose clinic extensive and systematic examinations for latent infection have been made before undertaking plastic operation on bones which have previously been the seat of infection. These examinations include studies of surface temperature, the leucocyte count in the neighborhood of the tissues in question, the sedimentation time, agglutination tests, and careful blood counts, and finally and most important, in attempts to elicit a local inflammatory response by various forms of mechanical, thermal, and chemical excitation, and by irradiation. Such tests, particularly the observation of the effects of mechanical stimulation (massage, tapping with a wooden mallet, etc.) and of exposure to X-rays have proven of very material value in the particular application mentioned. In the Northwestern clinic, investigations have thus far been restricted to mechanical excitation (massage or puncture), chemical stimulation (preliminary injections of small amounts of the medium to be used) and thermal excitation (exposure to diathermy). The latter method has been found of value by de Takats,<sup>11</sup> although Payr was not impressed by its usefulness in the field of plastic bone surgery. Further trials, particularly with X-ray irradiation, will be made.

The fate of the injection method will depend on a continuation of our present belief in its effectiveness and safety. Its effectiveness will be guaranteed by the proper choice of cases and liberal and appropriate combination with other therapeutic measures—matters which are not within the scope of this paper. Its safety will depend, at least in part, upon a clearer appreciation of the significance of resting infection and varico-phlebitis.

#### SUMMARY

1 Clinical evidence pointing to the existence of resting infection in the walls of varicose veins is presented.

2 The dangers of the injection treatment of varicose veins arise in part from the lighting up of such infection, with resulting ascending thrombophlebitis and embolism.

3 Evidence of the presence of latent infection in the veins of one extremity should call attention to the likelihood of stirring up such infection in the opposite extremity

4 The development of adequate methods of detecting latent infection will aid in eliminating an important source of danger associated with injection therapy

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# THE RELATION OF CHRONIC VARICOSE ULCER TO EPITHELIOMA

BASED ON RECORDS OF OVER 1,000 CHRONIC LEG ULCERS

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CUTANEOUS carcinoma of the lower extremities is of very rare occurrence Broders,<sup>1, 2</sup> in a series of 2,000 cases of general epithelioma, at The Mayo Clinic, recorded only twelve instances where the lesion was located on the lower extremities, and, furthermore, stated that over 96 per cent of his cases occurred above the level of the clavicle De Asis,<sup>3</sup> in a study of all cases of epithelioma occurring in two hospitals in St Louis, found that out of a total of 6,766 only eighteen were located on the lower extremities Simpson and Anderson,<sup>6</sup> in a series of 500 epitheliomata, found a total of only twenty-four cases for both upper and lower extremities

In a study of the same subject at the Kings County Hospital, Brooklyn, on the surgical service of Dr Joseph Tenopyr, fourteen cases of epithelioma of the lower extremities were found for the period 1921-1931, inclusive (Table I) The records for the entire hospital showed the presence of five more cases, making a total of nineteen cases During the same period over 1,000 chronic leg ulcers were admitted Many of the malignant cases came in with a diagnosis of chronic varicose, or trophic, ulcer A biopsy in each suspected case eventually revealed the true condition

TABLE I  
*Epitheliomata of the Lower Extremities*

No	Name	Age	Sex	Duration of Lesion in Years	Was sermann	Pathological Type	Treatment	Result	Site of Lesion
1	P M	54	M	20	neg	squamous cell	amputation	died	chronic varicose ulcer
2	J H	62	M	10	neg	basal cell	amputation	recovered	chronic varicose ulcer
3	M F	52	M	15	neg	basal cell	palliative	died	chronic varicose ulcer
4	M C	60	M	?	neg	not stated		not improved	chronic varicose ulcer
5	P B	57	M	15	neg	squamous cell	amputation	recovered	osteomyelitic wound
6	C H	60	M	18	pos	squamous cell	amputation	recovered	scar of old burn 18 yrs
7	E G	52	M	11	neg	no report	palliative	died	2 yrs after compound fracture of leg
8	F M	55	M	1½	neg	squamous cell	X-ray	improved	ulcer on heel
9	W A	50	M	1½	neg	basal cell	X-ray	improved	ulcer on heel
10	C C	75	M	40	neg	squamous cell	amputation	recovered	lesion on left ankle
11	A C	55	F	¼	pos	squamous cell	palliative	died	right leg
12	A S	62	F	1	neg	squamous cell	amputation	died	growth on left foot
13	A B	49	M	3	neg	squamous cell	X-ray	improved	left thigh
14	A W	77	F	1	neg	squamous cell	palliative	died	lesion on left foot

It was at first thought that a causal relationship existed between chronic varicose ulcer and epithelioma, but the results of the present study failed to substantiate this view, for only four of these cases gave a history of chronic

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varicose ulcers of long duration. Two others gave a history of ulcers of a few years' duration which may well have been malignant from the beginning, it being well known that rodent ulcers, and even squamous epitheliomata, may last for many years. Broders<sup>2</sup> states that the average duration for general epithelioma in his series varied from three months to forty-five years with an average of seven years. Sutton<sup>4</sup> states that the basal-cell types may last thirty years. It is obviously incorrect to conclude that because the lesion had hitherto been considered as a chronic infectious or varicose ulcer and



FIG 1

FIG 1—(Case I) Lesion began as an ulcer of the heel and was treated as such without improvement until biopsy revealed it to be a basal cell epithelioma.



FIG 2

FIG 2—(Case II) Epithelioma arising on the site of a chronic varicose ulcer. Patient had ulcers of both legs. First biopsy was negative, but one year later a second revealed the presence of an epithelioma.

recent biopsy shows the presence of an epithelioma, that the benign chronic ulcer has undergone malignant changes. This difficulty is all the more great since White<sup>7</sup> and Weidman<sup>8</sup> have recently shown what they believe to be pseudo-epitheliomatous hyperplasia at the margins of cutaneous ulcers. This will be discussed more fully.

In this series, therefore, those cases where the onset of symptoms were of less than three years' duration were classed as primary malignancies. Those cases that gave a history of previous varicose veins with varicose

ulcers, successful skin grafts, osteomyelitic wounds, compound fractures, or burns, were considered as non-malignant chronic ulcers up to the time when the records showed that sudden proliferation, erosion, sloughing, and cachexia occurred, or biopsy revealed the diagnosis. Of the fourteen cases which are the subject of the present report, five gave a straight history of primary skin carcinoma, and two more a history of ulcers of less than two years' duration which were probably malignant from the start. The remaining seven gave a history of a previous benign lesion as follows: Varicose ulcers, four, osteomyelitic wounds, one, compound fracture, one, ulcer in scar of old burn, one. In two cases biopsies taken at intervals of four months and one year revealed a change from the benign to the malignant. However, too much reliance was not placed on these findings as the original biopsy may have been taken from a non-malignant portion of the wound which had resulted from secondary infection and necrosis of normal tissue. The following case illustrates this point very well.

CASE I—C C, a white male, aged seventy-five years, complained of an ulcer on the internal aspect of the left ankle. Forty years ago there appeared a small scab-like formation in the same region. It grew larger slowly and itched severely. He had it removed by electrosurgery. Some time after this the lesion recurred, became "mushroom-like," and a series of wart-like growths spread up the leg following the lymphatics. Various diagnoses were made at this time. On admission to the Kings County Hospital the left leg showed a large ulcerating lesion of the ankle with indurated, heaped-up borders. A biopsy taken at this time revealed "areas of ulceration of the epidermis, small round-cell invasion with plasma cells especially around the coiled gland ducts numerous colonies of Gram-positive cocci."

Four months later another biopsy was taken and this time the report was different: "marked hypertrophy of the epidermis with considerable keratosis. Situated in the derma and subcutis is a neoplasm composed of irregular islands and columns of squamous epithelia. Pearl formation is absent. Some of the squamous cells are markedly enlarged. The general architecture of the tumor would place it in Grade I. Diagnosis—Squamous-cell epithelioma."

This case was undoubtedly one of epithelioma from the very beginning despite the biopsy and was masked by the extensive secondary infection of the skin.

Recently White<sup>7</sup> and Weidman<sup>8</sup> described cases of ulcers in which biopsy reports were made of grades I, II, and III malignancy which healed under the treatment given for benign ulcers. Their cases, however, occurred chiefly in young persons under thirty-three years of age, their duration was in each case less than two years, and they were all of comparatively small size, five by one centimetres in diameter or less. In the present series, on the other hand, all the patients were in the cancer age, most of them in the fifth decade, and the lesions were either of long standing, having healed and broken down several times, or were so extensive as to involve the major portion of the extremity and erode bone. The smallest lesion was seven and a half centimetres long and the largest over thirty. It will be remembered that most of these patients were from the lower strata of the population and were very

neglectful of their personal hygiene As the lesions were quite painless, hospitalization was greatly delayed

Only three females were affected in this series as against eleven males, a ratio of almost 4 : 1 This is in accord with Broders'<sup>1,2</sup> series for general epithelioma of the body where the same ratio prevailed In De Asis' series, males also predominated 2½ : 1 All of the cases occurring secondary to benign lesions were in males, the three female cases being all primary epitheliomata Knox,<sup>5</sup> in a very careful study of the literature, collected a series of fifty-nine cases of epithelioma secondary to chronic varicose ulcers and about an equal number arising on scars of burns or fistulæ In her series males and females were almost equally affected But varicose veins and varicose ulcers are much more common in women than in men<sup>14</sup> Apparently, then, chronic varicose ulcers seem to have little influence, if any at all, on the incidence of malignancy

The scars of burns, on the other hand, played a larger part in the incidence of epithelioma in Broders' series, for one-fifth of his cases had such a base of origin Epithelioma arises in lupus scars frequently,<sup>10</sup> 2 per cent according to Zweifel-Payr The same authors state that it is almost never seen arising in the active stage of the tuberculous lesion The incidence of epithelioma in chronic varicose ulcers in the present series was 4 in 1,000, or 0.4 per cent This is indeed a low figure if we believe that chronic irritation to which a leg ulcer is constantly being subjected has an influence on malignancy, especially with the use of ointments and irritants to stimulate granulation over periods of months and years These figures compare favorably with a similar experience of Gottheil,<sup>12</sup> who saw only three cases of malignancy arising in chronic varicose ulcers at the Metropolitan Hospital, New York The collected cases of De Asis showed that only one of the eighteen epitheliomata arose in connection with a varicose ulcer Volkmann,<sup>13</sup> Nobl,<sup>9</sup> Grosser,<sup>11</sup> Gant,<sup>16</sup> and DaCosta<sup>17</sup> had similar experiences One cannot fail to be impressed, therefore, with the fact that the chronic varicose ulcers, in spite of their duration of ten or twenty years, and in spite of the fact that they occur in individuals living in the decades when epithelioma is most common, play only a very minor rôle, if any, in the causation of cancer

The part played by syphilis has been stressed by some writers In this series only two cases gave a history of a positive Wassermann

#### SUMMARY

(1) Nineteen cases of epithelioma of the lower extremities occurred at the Kings County Hospital for the period 1921-1931, inclusive

(2) Over 1,000 chronic leg ulcers were admitted during the same period

(3) Only four cases of epithelioma were found among these arising on the sites of such ulcers that had been present for ten to twenty years

(4) The weight of evidence, therefore, is strongly against the common belief that chronic ulceration over prolonged periods plays an important rôle in the causation of cancer

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# THE PROBLEM OF DELAYED UNION AND UNUNITED FRACTURE

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IN TREATING the police and firemen we deal with a large number of men who perform hard, manual work and who are very liable to severe injury. We have a large number of these two surgical conditions to treat. The memory of our surgical failures as well as those of other surgeons is constantly with us. The surgeon who does not make mistakes makes no great progress. The best of men and the most earnest workers will make enough mistakes to make them humble.

The object of this address will be to emphasize some of the etiological factors of delayed union and non-union, and to suggest certain methods of reducing the liability of these complications. It is realized that delayed union, non-union and pseudo-arthritis may be three separate entities, often with varied etiological factors and requiring different treatment, but for the purpose of this paper they will be considered together.

Wilcox<sup>1</sup> has aptly said "This is an age of acceleration, mass production, high-speed machinery, automotive and aerial activity." This ever-increasing demand for greater speed and more thrills connected with the desire for more hazardous sports is largely accountable for the increasing number of physical injuries, especially fractures. One often wonders when this craze for thrills and speed will end.

In order to emphasize some of the points with a view of appreciating exactly the incidence of ununited fracture, 11,683 fracture cases treated at the Philadelphia General and the Jefferson hospitals from 1921 to 1931 have been reviewed. There were 101 cases treated for non-union.

The occurrence of delayed union, according to Von Bruns, is one-half of 1 per cent, according to Scudder, 2 to 3 per cent, according to Heygroves, 4 to 5 per cent.

As the number of fractures is ever increasing, so the complications of fractures, including non-union, will increase. With the advent of motorized fire apparatus, motor-cycles, sidecars and bandit chasers our problem of dealing with fractures is a serious one. Severe accidents at fires are not as frequent as heretofore. This reduction is due to saner methods of fire prevention, fewer fire hazards and better construction of buildings. Transportation to and from fires is far more hazardous because of congested traffic.

The problem of fracture heretofore was one which concerned principally the surgeons of our city hospitals. There were two reasons for this. First the majority of fractures occurred within the city limits, secondly, the more

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severe fractures which occurred in the rural districts were usually transported to a city hospital. At the present time the frequency of automobile accidents on the crowded public highways renders it imperative that the physician in each hamlet, village or even at crossroads be prepared to render proper treatment for fractures. These cases are now transported to a nearby hospital rather than to a city hospital, so that the surgeons of these suburban hospitals are now called upon to treat the more serious cases occurring in the suburbs.

Regarding the treatment of fractures by the general practitioner, Wilson and Cochran<sup>2</sup> remind us that, notwithstanding the lack of suitable facilities, the same standards of treatment and the same qualities of results as obtained in the best hospitals are demanded by both the public and the courts.

Modern text-books on surgery divide the etiology of delayed and non-union into two main classifications—constitutional causes and local causes. These statements, like many others in our text-books, have been repeated from one edition to another without contradiction.

Constitutional factors have but little, if anything to do with the union of fractures. The diseases usually enumerated as causative factors of delayed and non-union are syphilis, tuberculosis, diabetes and blood dyscrasias. In our series of 101 cases, the Wassermann was positive in six cases, negative in ninety-one, not taken in four, the blood chemistry was normal in eighty-nine, abnormal in six, five of which showed a hyperglycæmia and one a hypoglycæmia, not being taken in six, pulmonary tuberculosis was noted in two cases.

Campbell<sup>3</sup> states we do have constitutional ailments which prevent union but that they are so rare that, excepting in those fractures which are infected, union will occur in 95 per cent of the cases, and that non-union of fracture is undoubtedly caused by local interference with the physiological or nature's attempt at producing union.

Newell<sup>4</sup> does not believe that systemic conditions have anything to do with union or non-union. He considers the condition an entirely local one.

Wilson,<sup>5</sup> from his studies, agrees with Henderson<sup>6</sup> that local causes are far more significant in the development of non-union of fracture than general or systemic causes but states that the chemical analysis of the blood to determine the calcium and sulphur content is valuable in a small number of cases.

Henderson, in discussing this subject two years ago, stated that in The Mayo Clinic up to that time, so far as he knew, there had been only one case of non-union which could actually be ascribed to syphilis.

Culbertson<sup>7</sup> has found that in normally healing fractures the catabolism of calcium shows but little change. There is a marked loss of nitrogen, phosphorus and sulphur, the main excretory path for these catabolites being the kidney. He, further, found that metabolic analysis did not throw any light upon the problem of ununited fracture. A catabolic loss of sulphur, nitrogen and phosphorus may result from injury to tissues other than bone.

The majority of writers, as pointed out by Lacey,<sup>8</sup> do not believe that the calcium and phosphorus index can be used as a prognostic index of union or non-union.

Bohler<sup>9</sup> believes that such diseases as tuberculosis and lues and even osteomalacia and rickets, only delay but do not prevent union. He adds that non-union after fractures of the shaft is chiefly found in powerful and healthy individuals and disproportionately

## DELAYED UNION—UNUNITED FRACTURES

more common in men than in women We found in our series seventy-three cases of ununited fracture in the male and twenty-eight in the female One reason for the disproportionate frequency of non-union in men may be due to the fact that men are subjected to more severe injury, and, being more muscular, there results greater shortening and greater trauma in attempts to reduce this shortening Certainly rickets cannot be a cause of non-union as orthopædic surgeons deliberately fracture rachitic bones and non-union is practically unknown

As quoted by Pat Fite,<sup>19</sup> there are some surgeons who believe that osteoblasts occur either from migration at the ends of bone or are formed from newly made connective tissue by metaplasia and that due to the activating enzymes produced in these cells calcification is brought about Other workers at the Presbyterian Hospital in New York fairly recently have sought to show that from their experiments this is not the case, and further, that the available source of calcium at the site of the fracture is due to tissue death and that an enzyme if formed is due to the death of this tissue and is probably affected in no way by the blood calcium

Fite also notes the fact that non-union of the tibia occurs where there is poor lateral blood supply and also believes that in certain cases of fracture, as in the case of the neck of the femur or tarsal scaphoid, that union is affected by being bathed in synovial fluid He believes that fractures bathed in synovial fluid are hampered to some extent in union because of slow and perhaps imperfect callus formation Other surgeons deny this

Bohler cites as the causes of non-union lack of reduction of fragments and interposition of soft parts, and emphasizes that the most common cause is insufficient and inadequate early treatment

It is interesting in this connection to consider the thoughts of some of the earlier surgeons Black,<sup>11</sup> writing in 1797, states that his era was "an age of investigation of fractures in which mankind was eager to attain even absolute perfection" He observes "Although the science of surgery has reached a very high degree of perfection, yet there still exists considerable disagreement of sentiment on many points and perhaps none more than on which is the best mode of treating fractures" He adds that "falls, blows and bruises are said by many writers to be the common causes of fracture, but a little examination and reflection will be sufficient to prove that muscular action is a very principal agent in the production of fractures" Black further reflects that "in addition to this, we may observe that persons who are drunk or under the operation of any cause that produces relaxation of the muscular system, although they fall from a considerable height, seldom receive a broken bone" Even now, as then, a strange providence watches over those who violate the spirit of the eighteenth amendment

Certainly fractures by muscular action are not as frequently complicated by non-union as fractures received by direct force In our series of cases the primary injuries were

Falls	47
Automobile accidents	24
Blows by external forces other than automobile accidents	24
Crushing injuries	4
Gunshot wound	1
Stab wound	1

We found that non-union occurred in the first decade of life in three cases, in the second decade of life in eight cases in the third decade of life in nineteen cases, in the fourth decade of life in nineteen cases in the fifth decade of life in sixteen cases in the sixth decade of life in sixteen cases, in



the seventh decade of life in eleven cases, in the eighth decade of life in seven cases, in the ninth decade of life in two cases. Of those occurring in the first decade, one was in a child three and one-half years old who was struck by an automobile and sustained a fracture of the left femur. The child was admitted to the hospital two months after the injury with non-union of the fracture. The second case was a child six years old with a fracture of the left humerus and non-union for two years and eight months. The third case was that of a child ten years of age with a fracture of the right femur, non-union duration of three months. These are unusual, as union occurs far more readily in the young than in the old. In this connection it is interesting to note that Gross reported firm union in a fracture of the humerus occurring in a patient whose age was one hundred years.

Local causes as etiological factors in delayed and non-union are far more important than constitutional factors. The most frequent of the local causes are Lack of proper apposition or approximation of fragments, interposition of foreign tissue, injury to the blood supply, presence of foreign bodies in fracture zone, infection, and lack of proper fixation.

The question of nerve injury as an etiological factor is doubtful. There was but one case of our series which was associated with a nerve injury, that of a child thirteen years old, who sustained a fracture of the left humerus associated with musculospiral palsy. The case was admitted to the hospital eight months after the accident with non-union and wrist drop, but this does not necessarily mean that the musculospiral palsy was a factor in the non-union.

Injury to the blood supply is a well-recognized cause of non-union.

Cox<sup>12</sup> has emphasized the necessity of allowing for free circulation through veins and lymphatics as well as through arteries as through the medium of the veins and lymphatics the old structure is torn down and absorbed, thus permitting the growth of new vessels to form and the establishment of anastomosis so essential to bone repair. If resistance to expansion (swelling) occurs, its effect will be to diminish or occlude the veins, lymphatics and arteries, thus preventing an adequate supply of blood from reaching the interior of the callus. It is of great importance to prevent hæmorrhage, swelling and inflammatory reaction, especially during the early days of a fracture.

Impairment of the blood supply as an etiological factor in non-union was emphasized by Lacey in his excellent paper read before this Academy in 1929.

Bankhart<sup>13</sup> believes that the one common cause for non-union is the absence of hæmorrhage from between and around the fracture surfaces. He states that bones bleed when they are broken and usually there is considerable hæmorrhage between and around fracture surfaces. Extravasated blood, acting as a stimulus, produces the first step in the repair of the fracture. When for any reason sufficient hæmorrhage does not occur at the site of fracture, the natural stimulus for repair is lacking. He states that this is distinctly common in the case of fracture of the neck of the femur in an elderly person, not, as usually stated, on account of malnutrition of the fragments but simply on account of the absence of hæmorrhage, for these fractures are practically dry. He does not think imperfect immobilization is a causative factor, because, as he quotes "Fractures of the ribs and other bones unite readily in spite of constant movement." He believes that systemic diseases are often causative in non-union because they are associated with arterial changes and, therefore, the bleeding around the ends of the fractured bone is very slight. For

delayed union he advocates the injection of autogenous blood around the site of the fracture. Bier has also used this method. Bier has also advocated the use of hyperæmia for delayed union. Diathermy and the use of certain therapeutic lights may be used to increase vascularity.

In this connection, it is interesting to note that it has been recognized for many years that irritation between the fragments will often stimulate osteogenesis. Celsus<sup>14</sup> used acupuncture and introduced bristles between the fragments to stimulate union. The insertion of ivory tacks and the injection of bone-marrow was used by Wyeth, in 1878. Thomas percussed the tissues over the ends of the fragments with a rubber hammer. Lannelongue and Menard<sup>15</sup> advocate the injection of a few drops, 1 to 10 solution, of zinc chloride between the fragments.

Proper allowance should always be made for the expansion of the soft parts. This has been further dwelled upon by Newell,<sup>16</sup> who contends that the most important consideration in the treatment of a fracture is to maintain a good blood supply to the broken bone and to allow for free anastomosing circulation with the blood-vessels coming from the soft parts to the bone. He further directs that there should be as little manipulation of the bone as possible so as not to disturb the periosteum.

Cowan<sup>17</sup> attributes the cause of non-union to local anatomical conditions resulting from laceration of the periosteum, usually flush with the fracture line and separation of the fragments.

Callus is formed from bone-marrow from the broken splinters of bone, periosteum from the muscles attached to the bone and from the hæmatoma which is mixed with the fat of the bone-marrow.

Bohler believes that too short and interrupted immobilization of fractured bones is the cause responsible for non-union. Extensive detachment of the periosteum produces a large subperiosteal callus. Bohler has shown that in transverse fractures of the lower third of the tibia and in the middle third of the radius there is produced only a very slow-growing callus. He believes that to obtain firm union in fracture of the tibia from ten to twenty weeks are necessary and for fracture of the radius from six to twelve weeks, believing that the cause of delayed union in these bones is based on the fact that the bone-marrow in these fractures is open only in a small area. He reiterates that the cause of delayed union in fractures of the tibia is due to the fact that the anterior and medial surfaces are not covered by muscles and the blood supply to this area is, therefore, poor. It can be shown by means of the X-ray that in fractures of the lower third of the tibia callus formation takes place only on the lateral and posterior surfaces, while upon the medial and anterior surfaces, not covered by muscle, bone formation is frequently very slow.

In speaking of the rôle of bone-marrow in union, I am reminded of the quotation of an English surgeon<sup>18</sup> who said to his students: "You may think, gentlemen, the shaft of a long bone is occupied by marrow, but do not believe it, the medullary cavity is filled with base, black ingratitude which flows out when the bone is broken."

By what means may we possibly minimize the occurrence of delayed and non-union? Groves<sup>19</sup> has aptly stated that the three main types of mistakes in the treatment of fracture are neglect, delay and error of judgment. Delay in the efficient primary treatment of fracture accounts for three-fourths of the failures, which are frequently due to sheer carelessness or procrastination. Far too often a patient is admitted to the ward, and

nothing is done until the next day, when a skiagram is taken and the fracture may not be seen by the surgeon for a day or two unless some grave symptom arises. Every compound fracture should receive the same immediate care as a fractured skull or acute abdomen and the full surgical team should set about the problem. Extensive examination should take place at once, with no more delay than in the case of a ruptured gastric ulcer.

For the proper treatment of fractures one must understand the mechanics of fracture. We cannot agree with the deduction of Russell, who states: "The only one bone being fractured finds in gravity an ally and help in treatment is the humerus and for this reason fracture of the humerus should be the easiest of all fractures to treat." He also adds: "Gravity aided by a sling and bandage, with very little guidance from the surgeon, will do the rest." He speaks of the Balkan frame "with iron splints" as the crucifixion method of treatment.

The successful surgeon is one who is mechanically minded. It is realized that surgery is becoming more and more specialized. We have beds assigned to the neurological surgeons, thoracic surgeons, genito-urinary surgeons and other surgical specialties. In many of the larger hospitals fracture cases are now segregated. It is by no means advocated that the treatment of fracture should be considered as a specialty, but every hospital should have a fracture service. The surgeon who is not interested in the treatment of fractures should graciously refer these cases to the surgeon who is adapted for this work. This procedure should add to efficiency. The segregation of fracture cases facilitates the use of the necessary equipment and adds to the convenience of the surgeon.

There was once an old adage<sup>20</sup> "It is not necessary to go to a fracture as you would to a fire." This statement is untrue. Every fracture should be considered as an emergency.

Wilcox<sup>21</sup> remarks that "until not long ago the arrangement and treatment of fractures have been left to internes or junior house officers. Medical students should be taught that a broken bone is something more than a mishap and the laity should be made to realize the importance of this subject. There should be provision for immediate X-ray examination, both night and day. Assisting staff, internes and nurses should be definitely instructed in the methods to be employed for the treatment of fractures."

Findlay<sup>22</sup> strongly advocates that internes assigned to ambulance service should receive special instructions as to the first-aid treatment of fractures and additional instruction should be given ambulance drivers in methods of assisting the interne. He concludes that

(1) The internes appreciate having specific equipment and knowing definite methods for treating any particular fracture

(2) Their work is carried out more accurately, quickly, and gently with this knowledge and equipment

(3) When ambulance chauffeurs have been given specific instruction, they cooperate with and assist the internes

(4) The patients are more comfortable

(5) Shock is lessened or prevented

(6) Our results in the treatment of fractures in general have been definitely improved since proper treatment has been instituted at the site of accident

Bancroft<sup>23</sup> emphasizes that immediate replacements of fractures is imperative because "several hours after fracture the swelling due to hæmorrhage which infiltrates the muscle bundles is so excessive that replacement becomes difficult." Non-union may result from the fact that extremities often have to be suspended for several days in order to allow the

## DELAYED UNION—UNUNITED FRACTURES

swelling to subside before reduction can be attempted. He, too, emphasizes that allowance must be made for free and adequate circulation and that in cases where reduction is not attempted for several days the gelatinous consistency of the callus interferes with manual correction of overriding and to correct this deformity only long-continued traction may suffice.

Ashhurst<sup>23</sup> insists that reduction should be secured within a few hours of the injury "because if the surgeon postpones reduction he finds it increasingly difficult to secure because the reparative processes of nature will not await his convenience." He further emphasizes that delay and especially oft-repeated attempts at reduction not only do great injury to the soft parts, but are apt to hinder the progress of union with the result of delayed union or even non-union.

When the case is admitted to the hospital, before manipulation is attempted, X-ray studies should be made. The value of the biplane fluoroscopical screen cannot be over-emphasized. A single picture is of no value, excepting to diagnose the existence of a fracture, and it may fail to do even that. An X-ray of the entire bones should be made, with more than one plane taken. Some surgeons advocate taking an X-ray of the corresponding bone of the opposite extremity. The X-ray should be repeated after the fracture is reduced. Fractures should be reduced preferably by the findings of an X-ray and not by manipulation. We thoroughly disagree with Russell,<sup>5</sup> who writes that "X-rays are the indirect cause of much unnecessary operating on fractures," and that "X-rays can rarely demonstrate anything of importance which cannot be more easily demonstrated with a tape measure," but we do agree with him in his thought that the inspection of fracture films by patients may have serious psychological results because far too often the laity, and especially juries, lay too much stress upon a line of fracture *per se*.

To reduce a fracture muscular relaxation is imperative. This was recognized by the early surgeons, who obtained muscular relaxation either by means of alcoholic beverage, opium or blood-letting. Black states that "the reduction of a fracture is in general attended by little trouble since extension and counter-extension be all that in a majority of cases are requisite." Furthermore, that "unless laceration be great or the muscular system in such a state as to be easily thrown into convulsive action, the resistance given is seldom so powerful as to baffle the judicial efforts of two or three persons," but, he adds, "it has been not uncommon for us to see or hear of six or eight or as many men as can stand around the patient to use their utmost force to extend a limb, which force has sometimes even been so great as to tear the muscles to pieces while the unhappy sufferer must calmly submit to a fate fashioned by custom."

Black advocates the treatment of bleeding *ad deliquium animi*, producing a suspension of muscular action, that is, bleeding just to the fainting point. This, he states, is often successful and by this practice one can get sufficient relaxation of muscles so that the force of two or three persons will be all that is necessary to reduce a fracture. This practice of bleeding to the fainting point was also popular because the patient felt no pain from extension of the limb and replacement of the fragments. Fainting, it was said, could be produced with safety and readiness in proportion to the size and velocity of the stream of blood. Should the vein be small and the bleeding slow it was often necessary to open an artery. The radial artery at the wrist was the one usually attacked. Black frequently practiced this procedure with a lancet and stopped the flow by compress and bandage.

Black was not enthusiastic about splints. One of his chief objections to the use of splints for fracture was for the reason "men in general have a greater or lesser degree of bandy-legs and by the use of splints following fractures the leg is made to deviate from its former shape and from that of the sound limb which would be the case if completely straight."

He mentions the case of a man who had been accustomed to drink ardent spirits freely and whose whole system was in an irritant state. This patient fell to the floor and received "a very oblique fracture" of the bones of the right leg. During the first attempt

to reduce these parts severe spasms occurred and continued four or five days. During this time the lancet was used freely to dispose of the spasms. This was effected by repeated bleeding, cathartics and a vegetable diet. From the day of the accident to the ninth day he lost 125 ounces of blood, which conquered the disposition to spasm.

Black remarks that there are "some unfortunate cases in which the ends of the bone do not unite. The inflammation subsides and the integrants resume their former appearance, but the bones remain separate." This, he says, is usually due to the consequence of some disease in the part which destroys the first bond of union. In some cases certain authors advised an incision be made down to the bone and the ends of it be sawed off. This surgical procedure was practiced first by White, of England, in 1760.

Black also mentions a mode of practice which has been successful in his hands and at least merits a trial, namely, to make the patient exercise his limb by weight-bearing so as to produce inflammation, thus causing an extravasation of coagulated lymph and the parts are united by a kind of granulation, but he spoils this modern thought of treatment by adding "if this is unsuccessful all that can ever be necessary is to reduce it to the state of a compound fracture by a simple incision, for there are few, if any, cases in which union does not take place in compound fractures." He ends his argument by the following statement "I will close this dissertation on fractures by recommending free use of the lancet."

Instead of rendering a patient insensible either by the use of intoxicating liquor or by blood-letting, we now resort to anæsthesia to obtain muscular relaxation.

Local anæsthesia may be used. This form of anæsthesia in the reduction of fracture was first used by Conway,<sup>26</sup> in 1885, who reduced three cases of Colles' fracture and one posterior dislocation of both bones of the elbow by aid of a local anæsthetic. He advised injection directly into the fracture site, even though the fracture extended into a joint or into the hæmatoma about the site of fracture. This method was used by Reclus,<sup>27</sup> in 1903, Lerda,<sup>28</sup> in 1907, Quenu,<sup>29</sup> in 1908 and Braun, in 1913.

Hosford<sup>30</sup> advocates the use of novocaine, infiltrating around the fracture or into the hæmatoma at the site of fracture, or by injecting suitable peripheral nerves.

Mage<sup>31</sup> reports the use of regional anæsthesia by nerve block and advocates two methods to use: first, a field block which consists in creating an encircling wall of anæsthesia by infiltrating the tissues around the operative field, and second, nerve block which consists in making novocaine injection in close proximity to the nerve or nerves whose conductivity it is desired to cut off.

Gray<sup>32</sup> advocates the use of novocaine plus adrenalin chloride, but Wells in the discussion advised against using adrenalin because of the fact that the addition of adrenalin retards the desired rapid absorption of the novocaine. According to Wells one does not get good relaxation in local anæsthesia for the reduction of fractures in from 25 to 35 per cent of the cases.

Bohler does not use general anæsthesia for the reduction of fractures. He advocates local anæsthesia to reduce all recent cases. In isolated cases he uses regional anæsthesia, infiltrating the tissues around the fracture with twenty to fifty cubic centimetres of a 2 per cent solution of novocaine. In cases of fracture which are over two weeks' duration Bohler<sup>33</sup> blocks the brachial plexus to reduce fractures of the arm and advocates the use of spinal anæsthesia for fractures of the lower extremity.

The advantages of local anæsthesia are

A surgeon may attempt reduction when an assistant or anæsthetist is not available.

Reduction may be attempted in those who are too shocked to receive a general or a spinal anæsthetic, or in those who refuse a general anæsthetic.

The patient can go to the X-ray room alone.

The duration of the anæsthesia is from two to three hours and if the first attempt is not successful subsequent attempts can be made

Individuals with fractures of the upper extremities may go home immediately unassisted

It may also be used in cases of decompensated heart or conditions which would contra-indicate the use of general anæsthesia

The disadvantages of local anæsthesia in the reduction of fracture are

It cannot be satisfactorily used in very young children

It usually takes longer than a general anæsthetic

It is contra-indicated in open fractures and cannot be used when there is very much swelling present because it is difficult to inject novocaine exactly at the site of fracture

Spinal anæsthesia may be used to reduce fractures of the lower extremity when general anæsthesia is contra-indicated, but cannot be used in cases of shock associated with low blood-pressure, or in certain cases where the patient, because of associated injury, cannot be placed on his side

My personal experience with local anæsthesia having been limited, my preference is a general anæsthetic, although for a short case such as a Colles' fracture nitrous oxide and oxygen may be used. Ethylene would be ideal were it not for the fact that proper reduction must often be accomplished in the fluoroscopic room, which renders ethylene impracticable

General anæsthesia at the present time seems preferable, but with more experience in practice with local anæsthesia it may become popularized. General anæsthesia is not without risk because if the patient is not well under he may move at the crucial moment

It is not my intention to discuss the pros and cons of operative or non-operative treatment of fractures. In this connection I am reminded of the words of Wilhelm Von Humboldt "I lay very little stress either upon asking or giving advice. Generally speaking, they who ask advice know what they wish to do and remain firm in their intentions. A man may allow himself to be enlightened on various points, even upon matters of expediency and duty, but after all he must determine his course of action for himself."

An attempt has been made to emphasize the importance of early reduction with the least trauma. For reasons enumerated above any mechanical device which extensively tears the periosteum or traumatizes the tissues surrounding the fragments preempts the probability of delayed or non-union.

A large majority of fractures, if seen sufficiently early, can be reduced under an anæsthetic. The fragments can be held in good position by means of a properly molded plaster-of-Paris splint or case, skeletal traction or open operation. When reduction of the fracture is delayed or if the fracture is associated with swelling of the soft parts or considerable shortening of fragments exists any attempt to make forcible reduction by means of severe and rapid traction will do irreparable damage to the soft parts. The method of Soutter<sup>34</sup> is for this reason not advocated. For the same reason, although being a great admirer of Moorehead, his instrument is thought to be too

drastic Gradual traction by means of ice tongs or pins is preferable to any rapid method as such gradual traction produces less trauma to the soft parts

Hippocrates<sup>3</sup> mentions the use of extension and states that "for the most part two strong men will suffice" He advocates, "when the parts are adjusted you should apply the bandages while the limb is in a stretched position and when the limb is bandaged it should be placed upon some smooth or soft object so as not to be distorted to one side or the other, and that there may be no protrusion of the bones backward or forward, and for this purpose nothing is more convenient than a cushion or something similar, either of linen or wool, and not hard" He states that he is at a loss to advise that "gutters" below the fractured legs should be used, but found that a board is an uncomfortable thing to have a limb laid upon unless something be placed above it, but that it is useful in making subsequent arrangement of the bed or in going to stool He found that as the swelling subsides in a satisfactory manner the bandaged limb will become more slender, the bones will be more mobile and yield more readily to traction He states that the bones of the leg should get consolidated in forty days if properly treated and he cautions against tight bandaging For the swelling which complicates a fracture he advised the part should be wrapped in unsoured wool, washed with wine oil and anointed with serate before bandaging, and if splints give pain they should be slackened In speaking of fractures of the lower limb, he states that when the outer bone of the leg is broken the patient should soon walk about, but in fractures of the inner bone it is a long time before they can walk "It is a disgrace," he says, "to exhibit a shortened thigh, for an arm when shortened may be concealed and the mistake is not so bad" In fact, he says that "when the sound leg is placed beside the broken one, the sound one being longer than the other, exposes the mistake and, therefore, it would be to the advantage of the person who would be improperly treated that both of his legs should be broken, for in this case one would be the same length as the other" In his experience the thigh bone should be consolidated in fifty days

In speaking of the treatment of compound fracture, Hippocrates notes that 'In those cases of fracture in which the bones protrude and cannot be restored to their place the following mode of reduction may be practiced Some small pieces of iron are to be placed below the levers which the cutter of stone makes use of, one being rather broader and the other narrower There should be three of them at least and still more so that you may use those that suit best, and then, along with traction, we must use these levers applying the under surface of the piece of iron to the under fragment of bone and the upper surface to the upper bone In a word, we must operate powerfully with the lever as we would do upon a stone or a piece of wood The lever treatment along with traction must be had recourse to on the day of the accident or the next day, but by no means on the third, fourth or fifth day for if delayed too long convulsions are apt to occur" In other words, Hippocrates realized the fact that when operation was indicated it should be performed early

If the fragments of a fracture cannot be satisfactorily held by conservative measures it is far better to anticipate delayed or non-union and operate early, for, as pointed out by Whitman<sup>36</sup> "Operative treatment in fractures is indicated when a satisfactory reduction cannot be obtained and maintained by non-operative methods, provided there is no contra-indication and when the expected result of the open method is sufficiently better than the closed to justify the additional risk" Open operation when employed should preferably be undertaken during the first week after injury Fractures should be reduced immediately after the injury, but only when proper fixation apparatus is at hand

The method of operation by means of internal or external fixation or by wiring, plating or bone graft is not the theme of this paper It is interesting however, to note that Horeau, of France, first advocated the wiring of fractures in 1805

Early weight-bearing with proper fixation is of great assistance in the treatment of delayed union of the lower extremity, especially the tibia and fibula

Memmel<sup>37</sup> quotes the axiom of Aristotle that movement is life. He never preached that immobilization was death, but only that immobilization carried too far was responsible for many evils and certainly immobilization is frequently carried too far in the treatment of fractures

Bohler, on the other hand, warns against too short a period of immobilization for fear that "new shortening or bending take place." He advocates early active motion of joints and early weight-bearing provided there is proper external fixation. He prefers active motion to passive motion.

Although constitutional diseases may have but little effect on union, yet naturally the general physical condition of the patient must always be considered. Beneficial effects or irradiated ergosterol, viganol and feeding of other foods rich in vitamins has been employed. Phosphorus has been given internally and the newer osophyte has been used.<sup>38</sup>

Knoflach,<sup>39</sup> in the administration of ergosterol in doses of five to ten milligrams daily, noted an increase of the amount and density of the callus as compared with that in the controls. This increase began in the third week of fracture and was particularly great in elderly persons and children. In persons aged more than fifty-five the time required for bony union was distinctly shortened, but in other patients and other periods of life the difference in this respect was not significant.

H. A. Swart,<sup>40</sup> with his studies on the effect of irradiated ergosterol in the treatment of fractures of rabbits concluded that the administration of this vitamin did increase the rate of healing or the amount of callus formation in fractures of the tibia and fibula. He showed that there is some evidence that the administration of irradiated ergosterol to animals by mouth will produce a calcification in blood-vessels and other soft tissues. He found the most significant factor in the rate of healing and in the union of experimental fractures of animals is the degree of apposition of the fragments.

Israel and Frankel<sup>41</sup> found that fractures in guinea-pigs do not heal if the animals are kept on a diet free from vitamin C. A mere restriction of the vitamin does not impair the formation of callus.

Sir Ashley Cooper, over a hundred years ago, in his lectures on delayed and non-union, mentioned the fact that the improper diet of sailors on long cruises might be a causative factor in non-union of fracture so prevalent among these sea-faring men.

In conclusion it is urged that

- (1) More time be spent in teaching the medical student and the interne the proper mechanical factors in the treatment of fractures
- (2) Cases of fracture be considered more as emergencies which require immediate reduction
- (3) Such reductions should not be attempted unless proper fixation apparatus is at hand
- (4) An anæsthetic is usually indicated
- (5) Those cases of fracture in which the fragments cannot be properly approximated and held be operated upon early
- (6) Immobilization should not be carried over too long a period of time
- (7) Active and passive motion should be instituted early
- (8) Weight-bearing with proper external fixation is advantageous
- (9) Proper cooperation between the surgeon, his assistant, the interne staff, the laboratory and the roentgenologist be demanded



By these methods we can improve our fracture service, although probably never reach the ideal, for "ideals are like stars, you will not succeed in touching them with your hands but, like the sea-faring man on the desert of waters, you choose them as your guides and, following them, you reach your destiny"

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- <sup>36</sup> Whitman Quoted by Shearer U S Veteran's Bur Med Bull, vol 11, 1930
- <sup>37</sup> Memmel Clinical Jour, vol 1111, 1928
- <sup>38</sup> Bohler *ibid*
- <sup>39</sup> Knoflach Quoted by Swart Jour Bone and Joint Surg, New Series, vol 11, p 365, 1930
- <sup>40</sup> Swart, H A *ibid*
- <sup>41</sup> Israel, and Frankel Klin Wochenschrift, vol 11, 1926

# TRANSACTIONS

## OF THE

# PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD DECEMBER 7, 1931

The President, DR GEORGE P MULLER, in the Chair

CALVIN M SMYTH, JR, M D, Recorder

### OSTEOGENESIS IMPERFECTA TARDA

DR WILLIAM J RYAN presented a boy, aged thirteen years, who, in March, 1929, fell from a scaffold about eight feet. He was immediately moved to St Mary's Hospital. X-ray there showed a fracture of the surgical neck of the right humerus in good position and an intertrochanteric fracture of the right femur with slight decrease in the normal angle between the neck and the shaft. X-ray of the pelvis was negative for fracture. The fracture of the femur was treated first by the Russel method and after union had occurred a Whitman case was applied. This case remained on for eight weeks. On discharge, X-ray showed the fractures healed with abundant callus formation and in good position. Some time in the Fall, without any history of any injury having been given or being noted by the family, it was noticed that he walked with a decided limp, and on being questioned he complained of pain in the right ankle. X-ray at this time showed a fracture of both internal and external malleoli and a fracture across the lower end of the tibia with union in good position. Some time in February, 1930, he fell again and sustained a fracture of the left femur at the middle of the shaft. He was taken to another hospital, the fracture reduced and a case applied. This case remained on for six or seven weeks. Following its removal the boy was taken to school by an older brother in an express wagon and about three weeks after the case was removed while standing up beside his desk one day he placed his full weight on the left leg and turned and the femur gave way at the site of fracture. He was then brought to St Mary's Hospital and X-ray at that time showed a fracture through the middle of the shaft of the left femur at the site of an old fracture. There was slight outward bowing, callus was small and was not well calcified.

Realizing that this was probably a case of osteogenesis imperfecta tarda, the history was further investigated with the following result. He fractured one clavicle at the age of five following a trivial fall, then followed fractures of the other clavicle and the left humerus following trivial falls. The fractures of March, 1929, have already been described, also the fracture of the right ankle. He then sustained the first fracture of the left femur and the recurrence of this fracture for which he was admitted at this time. This boy was born through a normal delivery and weighed 7 pounds, 11 5 ounces at birth. Labor was short and there was no toxæmia present. He was nursed for only two months, when the mother's milk stopped. He was given milk, water and Dextri-Maltose. He remained on this formula until one year of age. During this period he had no cod-liver oil and no green vegetables, but he did have orange juice. At fourteen months of age he fell, striking his head. A mass formed over the right parietal region. This mass

was described as being soft, and a physician stated that fluid was present and it would be absorbed. He did not walk until eighteen or twenty months of age. He did not talk until three years of age. His first teeth appeared at three months and the rest followed in normal sequence rather earlier than normal. He has had chicken-pox and measles. Aside from the fractures he has not been subject to illnesses. Two years before his admission he received diphtheria and scarlet-fever antitoxin. From the age of five years he has been under the care of a competent pædiatrician and in addition to regulation of his diet he was given calcium, acterol and ultra-violet light. From infancy he has been puny, although the other six children in the family are robust, though not very large. At this period, his mother thinks there is some improvement in his growth and general condition and that his present mentality is above the average. He plays as other children do and is active physically. He has had his tonsils removed. The mother and father are living and well. There have been seven pregnancies with one post-partum hæmorrhage as the only complication and there are no fractures in the rest of the family. In no part of the family history is there any knowledge of a susceptibility to fractures of the bones or to blue sclerotics on either side.

The boy is undersized. While his head is not large, his forehead is rather square. *Teeth*—Good. *Tongue*—Clean and moist. Tonsils, absent. No blue sclerotics were noted at that time. The heart, lungs and abdomen are negative. There is definite deformity in the left thigh with forward and outward bowing with some shortening of the leg.

*Laboratory Reports*—Urine, normal.

*Blood Count*—May 13, red blood-cells, 3,930,000, white blood-cells, 11,000, hæmoglobin, 75 per cent, polymorphonuclears, 72 per cent, lymphocytes, 28 per cent. Blood calcium, May 15, 9.6 milligrams per 100 cubic centimetres, blood phosphorus, May 15, 4.7 milligrams per 100 cubic centimetres, Von Pirquet, May 15, negative.

May 17, red blood-cells, 3,840,000, white blood-cells, 7,600, hæmoglobin, 75 per cent, polymorphonuclears, 80 per cent, lymphocytes, 20 per cent.

Blood chemistry, May 17, sugar, 75 milligrams per 100 cubic centimetres, urea nitrogen, 13 milligrams per 100 cubic centimetres, creatinin, 1.3 milligrams per 100 cubic centimetres. Basal metabolism, May 17, plus 14 per cent. Platelet count, May 19, 120,000 per cubic millimetre.

X-ray examinations of the skull and of all the other extremities were made.

May 17, 1930—Plate of the skull shows the bone rather thin but there seems to be a normal calcification throughout the skull. The sella turcica appears to be normal and the sinuses are clear. Examination of the right wrist shows normal calcification with a tendency to increase at the epiphysis. The left shoulder is normal with evidence of an old fracture of the scapula and also of the clavicle, both of which are healed with normal calcification.

He was discharged May 20, 1930, after being in the hospital six days. The Whitman case was kept on for twelve weeks. This boy has been followed carefully and was also seen by Dr. A. Bruce Gill, who suggested the wearing of a brace on the left leg because this leg had a tendency to turn in. While wearing this brace, the boy fell and fractured the tibia at the junction of the upper and middle third, with the brace on the leg, this fracture healed rapidly. He has had no other fractures since although he has had numerous falls, but none of great severity.

In investigating the literature to obtain, if possible, some suggestions as to treatment other than those already known, the reporter found the work of Glassner and Hass and decided to try the administration of thymus gland

## NEW METHOD OF NEPHROPEXY

He obtained a commercial preparation which this boy took fairly regularly for a period of six months, and in the year since this therapy was started he has had no other fractures

As to the administrations of the thymus it was the ordinary commercial preparation of the desiccated gland that was used. It was given by mouth in five-grain doses once a day. It was brought out by the German investigators that apparently in man large doses could be given without any untoward effect. In their experiments, thyroid, parathyroid, egg albumen and other substances were compared. While parathyroid did give some favorable results, it did not compare with thymus. They studied two groups of patients and at the end of three months those who had received no thymus had fibrous union while those that received thymus have good solid union, the X-ray pictures showing that both cortical and medullary callus were well formed and solid.

## NEW METHOD OF NEPHROPEXY

DR IRVINE M. BOYKIN said that there have been devised numerous methods of suspending the ptosed kidney. In all of these operations the capsule proper is employed to hold the kidney in or near its normal position. At one time the operation of nephropexy was popular, but, judging from published statistics, the results were variable. During the last decade or more little has been heard of it. The reason for this is probably because of unsatisfactory results. The capsule proper is described in anatomies as being a substantial structure, but from a surgical standpoint this does not seem true. It is a flimsy structure consisting of a few layers of connective- and elastic-tissue fibres. Can such a structure, even with the aid of adhesions, hold the kidney permanently in place against gravity and loss of the kidney's normal support? Also, one finds in the description of these various methods of nephropexy no attempt to restore the normal axial planes. A failure to do this can result in torsion or kinking of the pedicle with interference of circulation and ureteral obstruction. It occurred to the speaker that a fascial transplant of a more substantial texture might be used in suspending the organ and that the fixation be done in such a way as to restore, at least, the most important axial plane—namely, the long. The procedure was first carried out on the fresh cadaver while the tissue were still pliable.

A lumbar incision is made of sufficient length to deliver the kidney (Fig 1). Along the convex border of the kidney two flaps of capsule one centimetre in width are outlined and stripped over each pole down to the hilum (Fig 3B). In anticipation of swelling of the kidney, resulting in damage to the parenchyma following suspension, the remainder of the capsule is stripped from the anterior and posterior surfaces.

The next step is to remove from the thigh a strip of fascia lata approximately 2.5 by 32 centimetres. A longitudinal slit is made in the centre of this, large enough to permit slipping the kidney through it (Fig 2A). The limb of the loop thus formed, which will support the inferior pole of

the kidney, is shortened by overlapping or reefing (Fig 2B) When the kidney is suspended, the shortening of the limb tends to restore the plane of the long axis namely, a tilt of the upper pole toward the spinal column The two strips of capsule which were turned down over the poles are now sutured to the superior and inferior limbs of the fascial loop, thus acting as a spreader to prevent impingement of the loop on the pedicle (Fig 3A) The kidney is returned to its fossa (Fig 3C) and the position in which it is to be fixed determined The accuracy of this depends upon the imagination of the operator

On either side of the lumbar incision near the posterior angle, a small

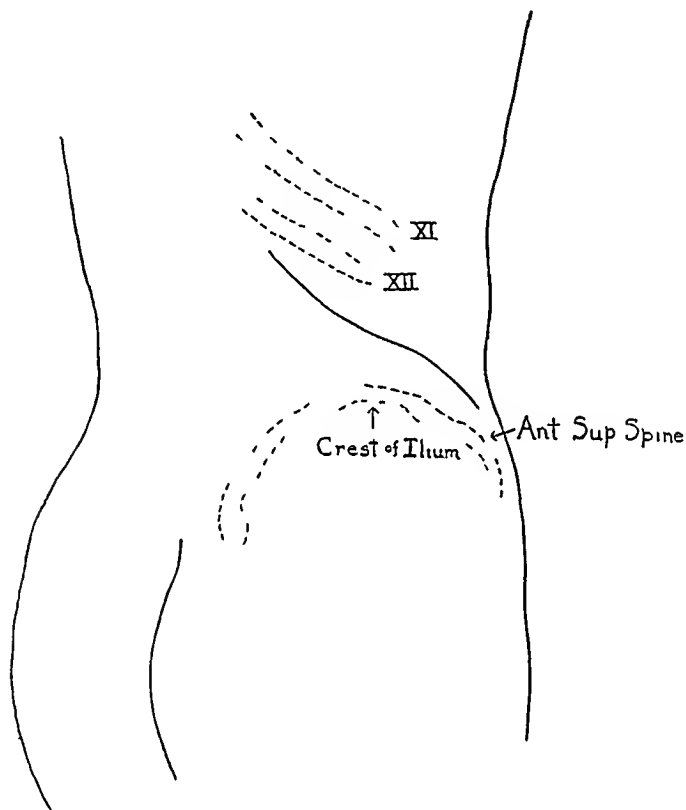


FIG 1 —Incision

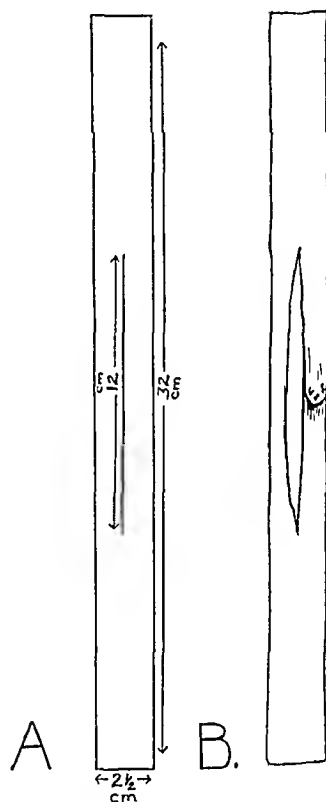


FIG 2 —(A)—Dimensions of fascial loop (B)—Shortening of inferior limb by overlapping

incision is made through all the muscle layers These must correspond to the position the kidney is now held in Through them are drawn the ends of the fascial transplant which are held taut while the vessels of the lumbar wound are being closed in layers (Fig 4A) The ends of the transplant are then overlapped, still being held taut and sutured together (Fig 4B)

To illustrate his remarks Doctor Boykin reported the following case

A woman aged fifty-four years, referred by Dr John B Hames, was admitted to the Episcopal Hospital June 23, 1931, with a history of pain in the right iliac fossa of five years' duration The pain was constant, dull in character and radiating to the right thigh Occasionally, the pain became severe enough to cause collapse Partial relief could be obtained by reclining

## NEW METHOD OF NEPHROPEXY

The points of importance in her past history were that she had borne two children, both difficult labors, demanding instrumentation. Following the birth of the second child, she was operated upon for a right inguinal hernia. Several years later a perineal repair and a suspension of the uterus was done.

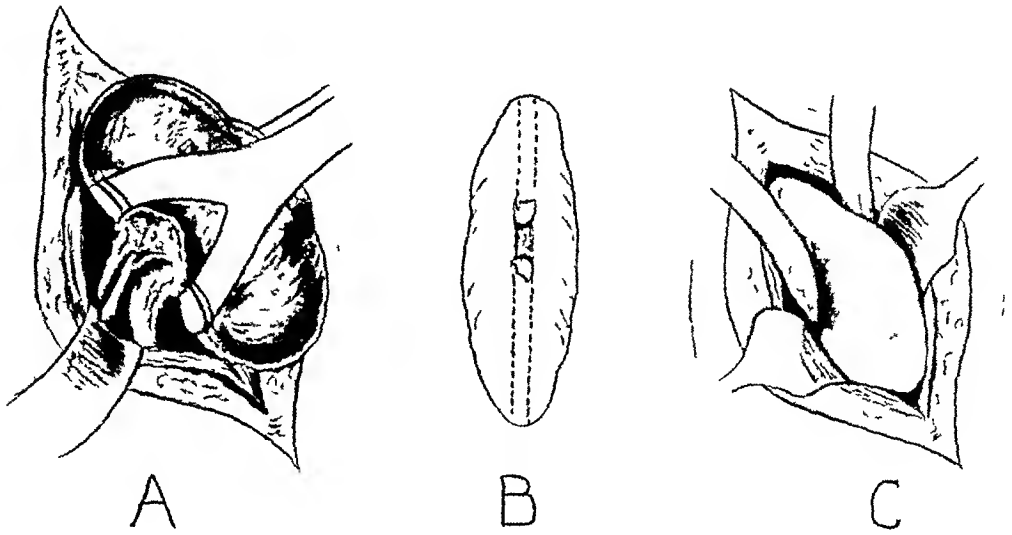


FIG 3—Method of suspending kidney with fascial transplant (A)—Lateral view. Loops in place around kidney (B)—Convex border of kidney. Strips of capsule outlined (C)—Kidney suspended in fascial loops

The abdomen showed two scars of previous operations. The muscle tone of the wall was very poor. The abdomen was pendulous, with marked diastasis recti. In the right iliac fossa the kidney could be palpated as a smooth, movable, tender mass. A previously gastro-intestinal examination showed a generalized splanchnoptosis.

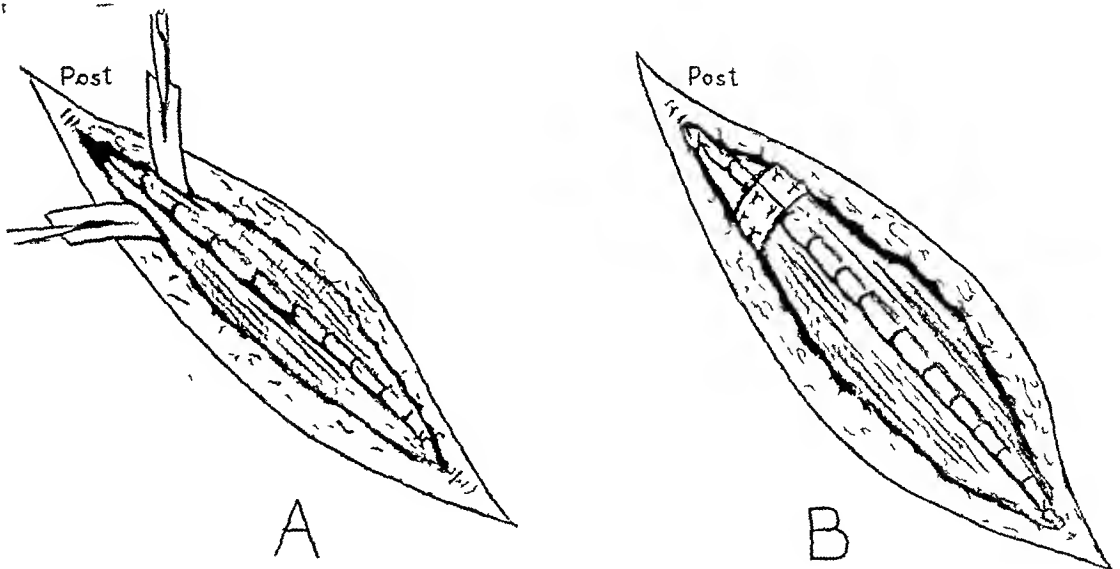


FIG 4—Closing incision (A)—Fascia ends brought through muscle at post extremity of incision (B)—Fascia ends overlapped and sutured

Cystoscopic examinations, April 10, 1931, gave a bladder picture normal except for distortion of outline by extra-vesical adhesions. Pelvis filled with opaque fluid and pyelogram showed the low position of the right kidney with marked dilatation of the pelvis and kinking of the ureter. In the erect

posture the kidney lies about an inch lower than it does when patient is prone (Fig 5) June 25, 1931, the woman was operated upon by the method described above

A pyelogram made October 23 shows a slightly dilated pelvis but with normal major and minor calices In supine position, the pelvis lies opposite the transverse process of the third lumbar In the erect posture it lies about on the level of the fourth lumbar (Fig 6)

Examination on December 3, 1931, showed the lower pole of the kidney palpable beneath the costal border There was no tenderness An indigo-carminc function test on this date was 8 minutes left side, 24½ right

This operation has been done in one case only While the speaker realized that its merit cannot be proven or disproven by this one instance, and although



FIG 5—Pyelogram before operation Note dilatation of pelvis and clubbing of calices

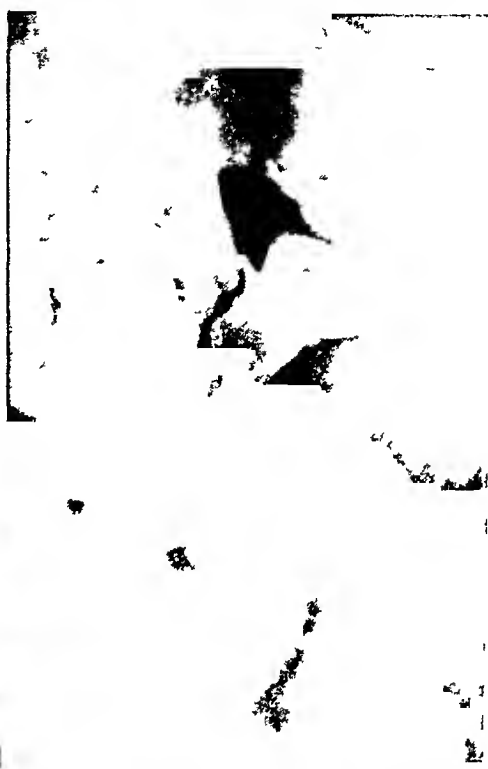


FIG 6—Pyelogram four months after operation Pelvis slightly dilated Calices wall deformed

it has been only six months since operation, the results seem sufficiently satisfactory to make it worth while describing

#### INTERLOBAR EMPYEMA DISCHARGING THROUGH A BRONCHUS (PLEURAL VOMICA), EXPLORATORY THORACOTOMY AND EXTRAPLEURAL THORACOPLASTY

DR ASTLEY P C ASHHURST and Dr IRVINE M BOYKIN presented a woman, twenty-two years of age, who was admitted to the Episcopal Hospital January 23, 1930, with the diagnosis "lung abscess"

As a child, she had had measles, chicken-pox, and mumps Two years ago she had been in this hospital with a pelvic abscess, following abortion, which had been opened and drained by Doctor Ashhurst, by "vaginal puncture" From this illness she had made an uneventful recovery On admission January 23, 1930, her chief complaint was cough and expectoration This

# INTERLOBAR EMPYEMA DISCHARGING THROUGH A BRONCHUS

had been going on for three weeks, during which time she had been sick in bed at home. She had been under the care of Doctor Nofer, who sent her to this hospital for X-ray examination of her chest. The report (January 3, 1930) was "marked density in right hilum, spreads down and out at about level of third rib anteriorly. At about the mid-clavicular line is an area of lessened density, within the dense area, which could be due to a lung abscess."

January 23, 1930, before her admission to the ward, Doctor Nofer punctured the right pleura because of physical signs of fluid, puncture about the angle of the right scapula drew nothing until after withdrawing the needle

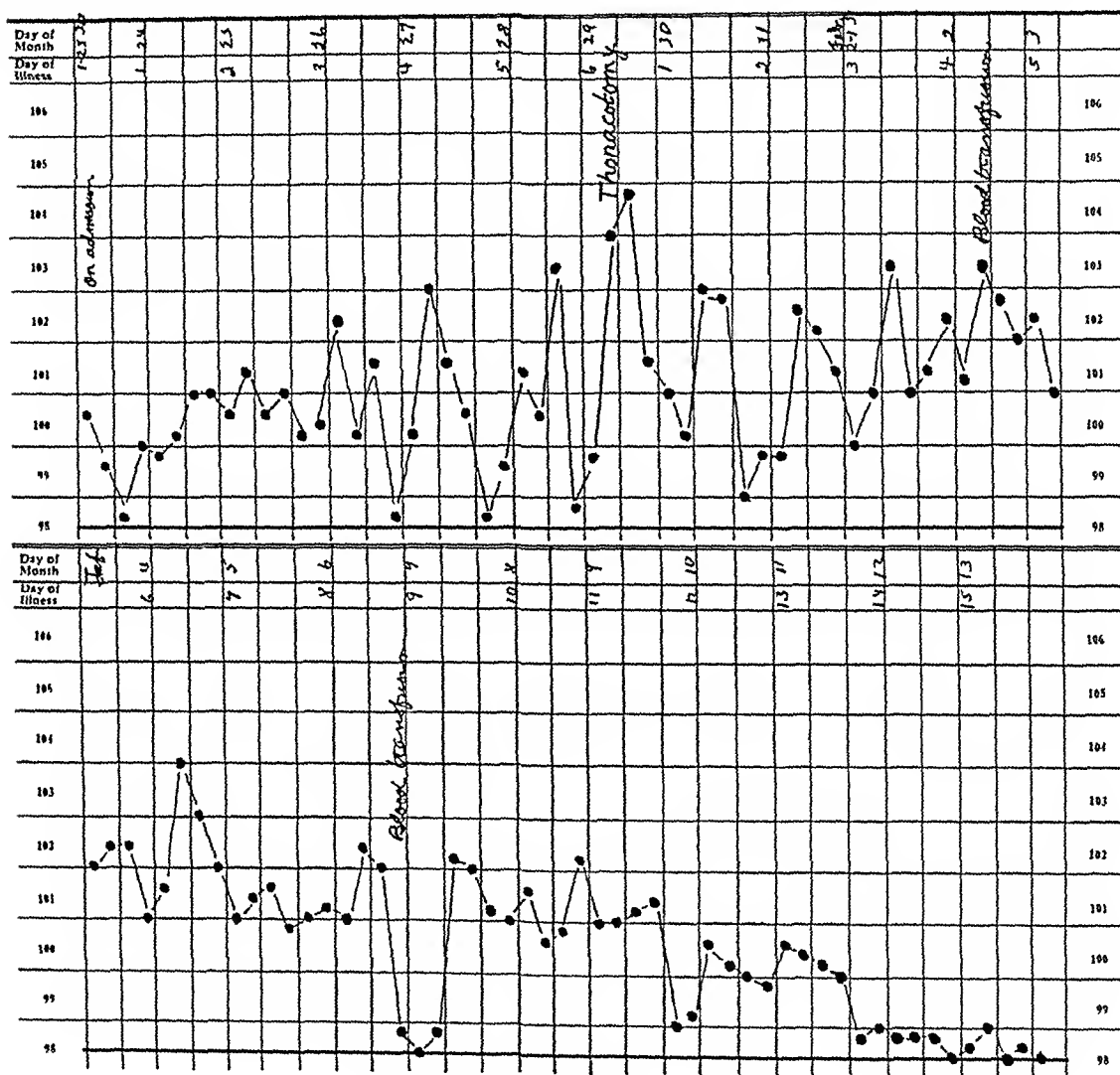


FIG 7—Shows the hectic temperature

from its deepest point of penetration, with continued suction, he obtained pus about one inch inside the chest.

There was almost persistent and constant cough with expectoration of very foul-smelling mucopurulent material (Fig 7).

Treatment consisted at first in "postural drainage," the patient lying on her right side in bed, with the foot of the bed elevated. She was seen in consultation by various members of the staff.

January 27, 1930, Doctor Ashhurst noted "Patient sitting up in bed, left chest normal posteriorly except many squeaking and sibilant râles. Right chest shows impaired resonance at the base, increasing to dullness between the scapula and the vertebræ. Auscultation shows at the right base numerous



large bubbling râles, between the angle of scapula and vertebræ there is cavernous breathing. Above this level breath sounds are absent, except at apex, which is normal. Palpation for tactile fremitus was unsatisfactory owing to inability of patient to speak loud enough."

The patient since admission had been placed twice daily in the position for postural drainage, fifteen minutes each time, with head and body over side of bed so that patient is practically standing on her head. Results: January 25, 1930, 25 cubic centimetres, January 26, 110 cubic centimetres, January 27, 180 cubic centimetres.

January 28, 1930, thoracentesis drew 20 cubic centimetres of dark straw-colored fluid, upon standing the lower part of the fluid remained straw-colored but without sediment, while the upper three-fourths of the fluid had a thick consistence and resembled the white of an egg. Two different punctures were made, and the same kind of fluid was obtained at both sites.

The first puncture was one interspace below angle of scapula, the second puncture in the same interspace, but in posterior axillary line.

During this time the patient's temperature ran a very septic course (Fig 1) from normal up to 103°F, and she was gravely ill.

The medical consultant, and the Röntgenologist, thought she had a pulmonary abscess, and such was the receiving ward diagnosis. Doctor Ashurst, however, concluded from the history, X-ray examination, clinical course and physical examination, that it was an encapsulated empyema discharging through a bronchus, with subsequent infection of the general pleural cavity, as the empyema, originally encapsulated in the interlobar fissures (X-ray before admission (Fig 8) began to leak at its periphery).

The term "pleural vomica" has been in use for many years to describe an empyema communicating with and partially draining through a bronchus. Gould's Medical Dictionary (edited by Scott, 1926) defines *vomica* as "1. A cavity formed by the breaking down of tissue, especially a cavity in the lung 2. (*vomere*, to vomit) a collection of pus in the lungs or adjacent organs that may discharge through the bronchi and mouth." Even Johnson's Dictionary (edition of 1828, which is a textual reprint of that of 1773) (which was the last revised by Samuel Johnson himself) defines *vomica* as an "encysted tumour in the lungs." Johnson quotes as follows from Arb on diet (presumably Arbuthnot) "if the ulcer is not broke, it is commonly called a vomica, attended with the same symptoms as an empyema, because the vomica, communicating with the vessels of the lungs, must necessarily void some of the putrid matter, and taint the blood."

E. Mosny (Nouveau Traite de Med et de Therap Gilbert and Thomot), (vol xxix, pp 222-230, Paris, 1910) says a vomica following interlobar empyema occurs late (six to eight weeks after onset of illness) whereas those which follow a primary abscess of the lung occur usually about fifteen days after the onset of the illness. The present patient's cough and expectoration began about two or three weeks after the onset of her illness. If Mosny's points of differentiation are correct, this would be in favor of the diagnosis of primary abscess of the lung, and against that of an encapsulated empyema. Most authorities at present appear to regard the differential diagnosis as very

## INTERLOBAR EMPYEMA DISCHARGING THROUGH A BRONCHUS

difficult and as of little importance, since by the time a surgeon is consulted, the lesions have become indistinguishable

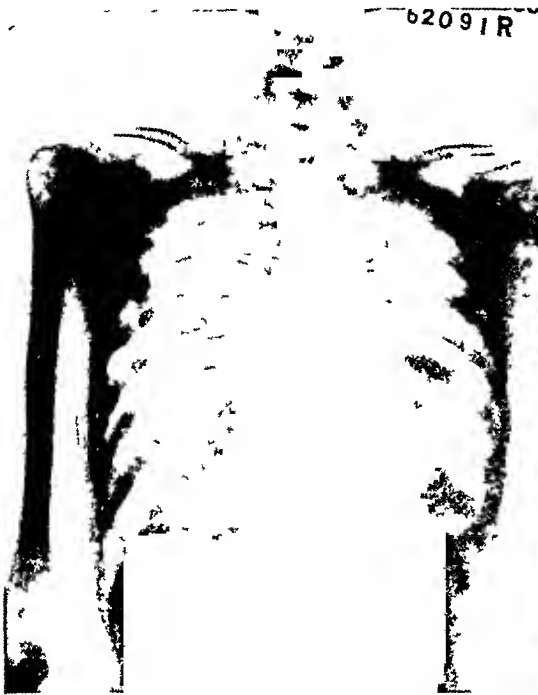


FIG 8—X ray January 3, 1930, three weeks before admission

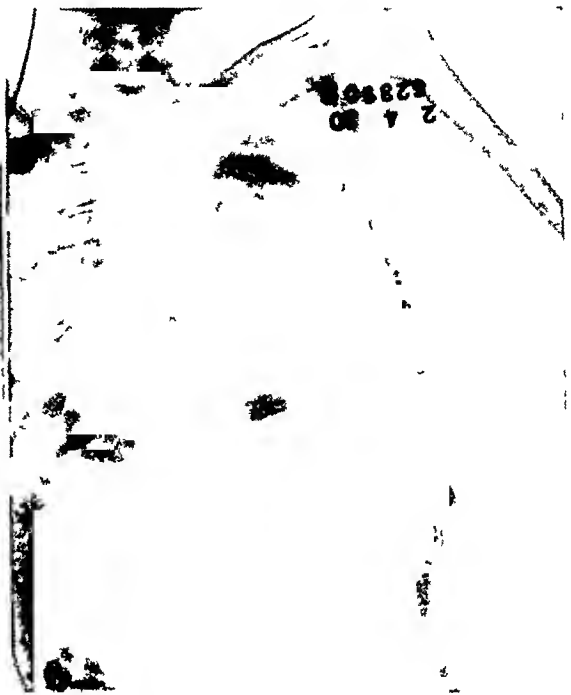


FIG 9—February 4, 1930, six days after thoracotomy for empyema

The prognosis of an encysted empyema discharging through a bronchus is poor, and it is difficult to find any accurate figures of the mortality



FIG 10—March 1930 before first stage of thoracoplasty Tube still in empyema cavity



FIG 11—April 21 1930, twelve days after upper thoracoplasty Note the interval between ends of resected ribs maintained by the intact lower ribs

Doctor Ashluist added that elsewhere (International Clinics, Twenty-sixth Series, vol iv, p 173, 1916, and Med and Surg Reports of the Epis-

copal Hospital, vol iv, p 226, Philadelphia, 1916), in advocating exploratory thoracotomy for cases of encapsulated empyæma and abscess of the lung, he had quoted Doctor Lord's statement (1915) that of five cases of pleural vomica under his care, only two recovered. Doctor Lord does not mention whether these patients were treated by operation or not. But the same author stated in 1919 (Osler Memorial Volume) that of unoperated cases of "lung abscess," the mortality is 63 per cent. In the paper just referred to, Doctor Ashhurst had recorded three cases of exploratory thoracotomy for pleural vomica (Cases I, V, and VI) with two recoveries and only one death (Case V). The present case, herewith recorded, makes a total of four patients with pleural vomica, treated by operation, with only one death.

*First Operation*—January 29, 1930, *exploratory thoracotomy*. With the patient prone on the operating table, and under local anæsthesia, the tenth, ninth, and eighth right ribs were resected posteriorly and the pleura was widely opened, purulent fluid was found lying anteriorly in the costophrenic sinus, and the lung adherent to the dome of the diaphragm. The lung, which was rather firm to the touch, was easily detached by blunt dissection, and no pus was found between it and the diaphragm. But the lung was densely adherent to the spinal gutter under the fifth, sixth and seventh ribs, i.e., the region overlying the interlobar fissure. Detachment of the lung from the costal pleura posteriorly gave exit to necrotic tissue, flakes of lymph and malodorous pus (the same as was being expectorated). A large iodoform gauze strip was placed in the abscess cavity in the lung tissue, and after removal of the isolating packs above the diaphragm, a second large piece of iodoform gauze, with a large rubber tube in its centre, was placed between the lung and diaphragm.

Throughout the operation, which consumed seventy minutes, there was no respiratory distress at any time, and no pain at all, except a little in detaching lung from spinal gutter. After this operation, the temperature continued to fluctuate, ranging from 99° to 103° F, but showing a tendency to reach normal, which it did six days after operation (Fig 9). Blood transfusions were given February 2 (200 cubic centimetres) and February 7 (80 cubic centimetres). The second transfusion was followed by a reaction (without chill but with rise of temperature to 102° F), which was nearly a week in subsiding.

From February 10 forward the patient was considered convalescent, her cough and expectoration being very much less, and sleep being secured without medication.

During March, the patient, who had been allowed out of bed for some time, developed a coryza, and had a recurrence of fever and slight cough. The physical signs of cavity in her lung remained practically unchanged, though there was not much discharge from the thoracotomy wound which required to be dressed only about twice weekly (Fig 10). With the object of collapsing the cavity in the lung, Doctor Ashhurst determined to do a two-stage extrapleural thoracoplasty.

Accordingly, April 9, 1930, he removed the posterior portions of the first to seventh ribs inclusive. The patient's temperature had been practically normal for one week before this operation, and there had been no discharge from the thoracotomy wound. This was thought to indicate that the abscess was walled off on the pleural side. The length of ribs resected varied from three centimetres of the first rib to eight centimetres of the seventh. During

## INTERLOBAR EMPYEMA DISCHARGING THROUGH A BRONCHUS

the operation, which was long (seventy-five minutes) and laborious, she had scarcely any pain. About sixty cubic centimetres of a 1 per cent solution of novocaine were employed. In view of the subsequent regeneration of the resected ribs, it was an error not to apply Zenker's solution to the rib beds, as advised by Hedblom (Lewis's Practice of Surgery, 1930).

After the first-stage thoracoplasty the patient began again to expectorate more freely. Ten days after the thoracoplasty the temperature reached normal, and the amount of expectoration was diminishing. April 21, 1930, it was noted that there was clubbing of the index fingers and thumbs of both hands. April 24, 1930 (Fig 11), examination indicated decrease in size of the cavity in the lung. Dr Robert C Colgan, medical consultant, noted "Judging from X-ray, and physical signs, there is about one-third collapse of right lung, and a well-defined collection of pus between fifth and ninth ribs posteriorly and second and fourth ribs anteriorly. However, there seems to be ample drainage."

April 26, 1930, the *second-stage thoracoplasty* (postero-inferior) was done. The eleventh, tenth, ninth, eighth and seventh ribs were removed. The operation, done under local anaesthesia, lasted about ninety minutes, and was well borne. The old pyothorax cavity was unavoidably opened when resecting the eighth and ninth ribs, as the drainage tract of this operation was found to have become surrounded by the eighth rib which had re-formed since the original thoracotomy three months previously.

Profuse drainage followed from the original thoracotomy incision, as the second-stage thoracoplasty had much more effect in diminishing the size of the pleural cavity which had been the site of the pyothorax than had been the first stage, as the main effect of the latter was upon the cavity within the lung (*i.e.*, the original interlobar empyema). Four days after the second-stage thoracoplasty, when the gauge packing first was removed from the old empyema cavity, the same foul-smelling pus was encountered as was being expectorated. This was taken to indicate that the cavity in the lung had reopened into the empyema cavity.

May 4, 1930, so much drainage from the empyema cavity as to require dressing twice daily (Fig 12).

May 13, 1930, postural drainage resumed today, morning and night, with patient resting on her hands on the floor, while her hips remain on the bed, not coughing or expectorating so much, and drainage from original thoracotomy wound is much less, while wound of second-stage thoracoplasty is almost healed.

May 16, 1930, requires to be dressed twice daily. Is pale and anæmic. No tubercle bacilli have been found in the sputum at any time, and only on one occasion have elastic fibres been found (but the examinations have all been made without special straining for elastic fibres).

May 19, 1930, the operation incisions are entirely healed, except for the sinus where the original thoracotomy was done, here a closed Kelly hæmostat can be introduced for about eight centimetres, and drainage appears adequate. It is dressed daily.

During June, 1930, the patient was out in the sunshine a good part of the time but was still confined to bed. She became tanned, and looked better.

June 25, 1930, the medical consultant, Doctor Colgan, reported "Patient is draining freely from the wound, and expectorating two to three ounces daily of sputum. There is very little change in the physical signs over the right lung. Believe patient should be built up generally—for further operative work. There is still free drainage of pus from the abscess and bronchi-

ectatic cavities, and the probabilities are that more radical measures will have to be done in order to get her well (cauterization of lung or lobectomy) "



FIG 12—Nine days after second (inferior) thoracoplasty One month after first stage (May 5, 1930)

FIG 13—Eight months after admission (October 2, 1930)

June 25, 1930, she spat up about four cubic centimetres of blood when doing postural drainage, during which periods she hacks and coughs very hard



FIG 14—Eight months after leaving hospital Healed firmly for six months (June 1931)

June 26, postural drainage stopped for a time

July 8, 1930, coughing and "vomiting" blood, and blood is coming out of

## INTERLOBAR EMPYEMA DISCHARGING THROUGH A BRONCHUS

sinus of original thoracotomy wound She is slightly despondent over her condition

July 11, 1930, no more coughing of blood and no bleeding from sinus

July 14, 1930, only slight drainage of mucopurulent material from wound  
Condition improved

July 29, 1930, Doctor Colgan reports physical signs in right lung indicate improvement There is very little if any moisture in the upper fourth of right lung Breath sounds are suppressed Her weight at this time was eighty-nine pounds

August 1, 1930, transfusion of 200 cubic centimetries of blood today

August 2, 1930, operation by Doctor Boykin Old scar including fistulous tract was excised between elliptical incisions, seventh, eighth and ninth ribs (which had reformed) were again excised, exposing a cavity which extended from ninth rib upward to fifth, lateral to mid-axillary line So far as could be determined, this cavity of the old empyema does not communicate with



FIG 15 —Photographs of patient one year after thoracoplasty (June 10, 1931)

the cavity in the lung The operative cavity was packed firmly with iodoform gauze Time of the operation, forty-five minutes

August 26, 1930, Doctor Colgan (medical consultant) reports many coarse, crackling râles scattered throughout lower half of right chest, anteriorly and posteriorly Upper third of right lung shows evidence of collapse, *viz*, suppressed breathing, no râles heard in this region Believe more radical measures will be necessary before the lesion will be eradicated deeper cauterization of bronchiectatic cavities and surrounding infected lung tissue

August 28, 1930, wound still draining some Cough diminishing, temperature practically normal

September 17, 1930, sent to convalescent home at Oakburne, Pa

September 27, 1930, readmitted Weight 91¾ pounds

October 11, 1930, X-ray examination after injection of lipiodol into the sinus Marked regeneration of ribs which were resected, excepting tenth and eleventh Upper level of sinus tract is at level of tenth rib Somewhat thin line of the opaque medium is shown reaching downward and upward from it

to the chest wall Still marked density in lower half of right chest in region of collapsed lung

October 22, 1930, patient discharged finally from the hospital, her temperature having been normal ever since her readmission, and there being very little discharge from the sinus

June 10, 1931, patient seen again in excellent health The sinus closed before December 25, 1930, and has remained closed ever since (Fig 15)

October, 1931, patient seen today After walking some blocks from her home to the hospital, and then ascending rapidly two flights of stairs (forty steps), she felt scarcely at all out of breath, and looked in excellent health Her weight is 120 pounds She has a good job, doing light work with enjoyment She has no cough at all and has not had since leaving the hospital

December 2, 1931, the patient when presented at the meeting was in excellent health The clubbing of the fingers has disappeared

#### COMPOUND FRACTURE—GAS GANGRENE

DR IRVIN E DEIBERT presented a man, twenty-two years of age, who was admitted to the surgical service of the Cooper Hospital, Camden, N J, October 14, 1930 While working in the third-story window of his home he fell out, his right arm being pinned underneath him Upon admission the patient was in distinct shock, temperature 96.2°, pulse 122, respirations 22 The lower third of the right arm showed a laceration about two inches in length, the end of the radius had apparently protruded through the skin The general physical examination revealed no other gross injury The wound was cleansed, a sterile dressing and a temporary splint applied, patient put to bed and treated for shock in the usual manner About four hours later he had reacted sufficiently to be taken to the operating room where nitrous oxide was administered, the wound inspected and cleansed and reduction attempted X-ray showed that the reduction was not satisfactory The following morning the general condition was not good, the arm was swollen and he complained of considerable pain at the fracture site

Sixteen hours after admission the temperature rose to 102°, pulse 100, respirations 22, and the swelling had extended to the shoulder-joint There was no crepitation present but a smear made from the wound showed a large number of bi-polar rods, chain cocci, and nails and spores, which were assumed to be *B. welchii*, *streptococci* and *tetanus bacillus* The *B. welchii* were later proven by laboratory culture On admission to the hospital the patient had been given 1,500 units of tetanus antitoxin, he was now given 100 cubic centimetres of the perfringens serum, the polyvalent serum not being available Preparation for immediate operation was ordered, amputation at the shoulder-joint being anticipated

After the administration of ethylene gas, the patient's condition became decidedly bad, marked cyanosis was present, the pulse was rapid and weak and at times imperceptible, the swelling in the arm had extended over the pectoral muscles almost to the root of the neck and it was felt that he would not survive a shoulder-joint amputation Accordingly, the arm was incised deeply into the muscle structures from the shoulder to the wrist, important vessels and nerves being avoided as nearly as possible, the wound at the fracture site was greatly enlarged and the periosteum was found to be of a distinct brownish color which stripped readily from the bones for a distance of several inches above and below the fracture site Twelve Dakin's tubes were inserted into the wounds which were then flushed with hydrogen peroxide packed wide open with vaseline gauze and a molded plaster splint applied

to the arm. The patient was then returned to bed, the Dakin's tubes were connected to a large tank of oxygen which was allowed to flow into the wounds continuously, the rate of flow being controlled by the ordinary wash bottle. Fifty cubic centimetres of perfringens antitoxin were administered every four hours.

On the day following operation the patient's general condition had improved somewhat, the swelling had not increased and there was no further extension along the chest wall. Three days later the general condition had improved to such an extent that the oxygen was discontinued and there were no further administrations of serum. One week after operation the Dakin's tubes were removed. This procedure was followed by a rise of temperature which at first was thought to be due to infection but later proved to be serum sickness, which subsided after about three days. Sixteen days after operation healthy granulations were present in the wounds and the amount of discharge was very small. An attempt was then made to secure better alignment of the fracture fragments. The vaseline gauze was renewed and a plaster case was applied after the method of Orr. No further complications developed, so the case was allowed to remain on for a period of four weeks. After three dressings of this type, each case being allowed to remain on for an average period of four weeks, the wounds were entirely healed. Active physiotherapy was then started and good progress was made for about one month, when the wound at the fracture site again began to discharge. The patient was readmitted to the hospital, the wound at the fracture site was opened and several small sequestra were removed. This was again treated after the technic of Orr.

Seven months after the accident, X-ray showed a beginning separation of about one inch and one-half of the lower end of the upper fragment of the radius. A review of the previous films failed to reveal a fracture line at this site. About six weeks were allowed to elapse and when the fragment had definitely separated the patient was readmitted to the hospital and this fragment removed, prompt healing followed.

One year following the injury a beginning flexion contracture was noted. This was much improved by stretching and the use of a cock-up splint. X-ray at this time shows mal-union of the ulna and non-union of the radius. Function is good considering the type of injury. He is able to play the piano very well at this time.

DOCTOR DEIBERT remarked that with the steady increase of the so-called street accidents an increase in the number of gas-bacillus infections is seen in civilian practice. Most surgeons who treat these infections had their first experience with gas gangrene during the recent war. There have been many excellent articles published on the subject during the past few years, particularly *The Treatment of Gas Gangrene*, Henry Milch, *ANNALS OF SURGERY*, June, 1931, and *Gas-Bacillus Infections in Civil Life*, W. E. King, *American Journal of Surgery*, November, 1931. The consensus of opinion seems to be that best results are obtained by early high amputation and the use of polyvalent serum, both prophylactically and as a therapeutic measure.

The reasons for reporting this case are that it was, apparently, a very rapidly progressing and extremely virulent infection, the patient did not have a prophylactic dose of serum, he did not have a high amputation and finally there was a separation of a fragment of bone from a point where no



fracture was shown in the primary X-ray film. The fact that pure oxygen was run directly into the tissues infected may have influenced the course of the case.

DR EDWARD B. HODGE recalled a case that had recently been under his care in which the deformity, fracture and result were very much the same as in Doctor Deibert's patient. Multiple incisions were made to cure the boy and he is now receiving physiotherapy. The speaker felt that serum had a very large influence in the patient's recovery and urged its early use.

DR CALVIN M. SMYTH, JR., said that in the treatment of compound fractures by the Orr method it had been his practice to give a prophylactic dose of perfringens and tetanus antitoxin and he has had no case develop gas gangrene.

DR I. E. DEIBERT said that at the time of admission the patient had very little done other than a superficial cleansing, since the patient was badly shocked. It has been the speaker's practice to give every patient with a suspicious wound a prophylactic dose of perfringens serum. This boy did not have it. He came in on a night when there was a change of internes and was the type of case which should have had it. The speaker felt that these compound fractures should be immediately cleansed and opened up wide. He rather believes that it does not make much difference whether the serum is given or not, the fact that one cleans them out is a step toward preventing anaerobic infection. Had he seen this boy he would probably have opened him up wide when he came in, after the technic of Doctor Orr.

DR JOHN SPEESE said that there is a very serious question involved here. Are surgeons to give a dose of serum in every compound fracture because it is a compound fracture, or because it is to be packed with gauze and encased in plaster? Does Doctor Smyth give it because he is using the Orr method? It is rather new to the speaker to think that every compound fracture should be given a dose of serum.

DR DAMON B. PREIFFER thought that compound fractures should be regarded not only as emergencies but as fit subjects for the mature judgment of experienced surgeons rather than the early efforts of younger house officers. It is interesting and important to know that gas gangrene may often be treated successfully without sacrifice of a limb, but it is still better to realize that appropriate early treatment of compound fractures will, as a rule, prevent the development of gas gangrene. The majority of cases of compound fractures of the long bones present ideal conditions for the development of anaerobic infections—namely, laceration of muscle masses, devitalization of tissues and anaerobic conditions. Opportunities for contamination are almost omnipresent. It should, therefore, be the first concern of the surgeon to alter these conditions in such a way as to prevent its occurrence or serious development. Naturally, the extent of the surgery necessary is

modified by several factors, such as the type and location of the injury, the degree and probable sort of contamination, and the associated vascular and other injuries. The size of the external opening is no definite criterion of the amount of subcutaneous injury. The speaker had come to believe that practically all compound fractures should have an anæsthetic and careful revision of the wound, that free and open drainage should be provided and that complete immobilization should be provided in the early and dangerous period. Joint cavities when involved should, of course, be closed. For about two years he had been trying the principles of the Orr method with the greatest satisfaction. While it may seem revolutionary and unwise to cover up the lesions of compound fractures, he as yet has had no occasion to regret it. As a matter of fact, the superior immobilization and the freedom from meddlesome interference are great advantages which more than counter-balance the apparent disadvantage. The success and safety of the method of dressing, however, depend not so much upon the dressing as upon the good surgery which should precede it.

DR HENRY P BROWN said that he thought that in civil practice as contrasted with military, it made a difference whether the fracture is compounded from within out or from without in, the latter being more apt to carry infection into the wound. He has seen cases in which the fractures occurred from within outwards cleansed and the fragments replaced without extensive debridement. If the patient does show signs of infection the wound can then be opened and treated accordingly, but why open it up when it is not necessary?

DR J STUART RODMAN recalled the case of a boy who had an extensive injury to the soft parts of his thigh, no fracture. He did a rather extensive débridement on him and despaired of saving his leg, and some thought it should be amputated. He felt, however, that the patient would have died from shock had he amputated and since the femur was intact and also the blood supply, he contented himself with a fairly extensive débridement but did give him a prophylactic dose of perfringens antitoxin. He developed gas gangrene, however, and was given numerous doses of the same antitoxin and fortunately they were able to save him, as well as his leg, but with a stiffened knee-joint. One can develop gas gangrene even after using perfringens antitoxin as a preventive measure, although the speaker felt that if he had not used it he would have lost this boy, as infection with this type of organism leads, of course, to profound toxæmia, unless, as in this case, its clinical course is altered by the early use of antitoxin.

DR CALVIN M SMYTH, JR, did not quite agree with Doctor Brown regarding taking a chance with ultra-conservative treatment on the ground that it is easy enough to treat infection if it should develop later. This is quite contrary to the speaker's experience, which is that when infection develops in these cases one has an osteomyelitis to plague both surgeon and

patient for a long time. It is not a question of whether one can get away without debridement but it is certain that one gets very good results by extensive operation and does no harm. As to the administration of perfringens serum, he gave the serum routinely in these cases for two reasons: first, because gas infection is relatively common in this type of street accident, and secondly, because it was his practice to treat most compound fractures by debridement, packing with vaseline gauze and encasement in plaster—namely, by the Orr method. He has always felt that in employing this method that one of its hazards was the closing up and the exclusion of air from a wound quite possibly contaminated with the gas bacillus. While he has never had a case of gas gangrene following the employment of the Orr method, he has always given a prophylactic dose of serum. The only cases of gas-bacillus infection that have been reported as complicating the Orr operation have been those in which prophylactic doses of serum had not been employed. He did not mean to suggest that most compound fractures would develop gas gangrene if the serum was omitted any more than most street injuries would develop tetanus if the antitetanic serum was omitted, but it would seem to be a perfectly logical procedure to give a dose of the combined tetanus and gas serum in this and similar types of street injuries.

DOCTOR DEIBERT said that in the Camden vicinity the soil is particularly rich with tetanus bacilli. He has not had a case of tetanus in the hospital for some time now. Two or three years ago he had one or two cases a year. Now it would seem that there is a remarkable increase in the number of cases of gas infection. He did not go into the number of cases in the hospital because of the time consumed, but he supposed they had an average of two or three cases of gas gangrene a year and he felt that in street accidents, particularly compound fractures, a dose of polyvalent serum in addition to tetanus serum should be given. If one waits until infection develops it is too late and the patient will have a bad result. As to the conditions favoring anaerobic infection, he thought that when one packs a wound with vaseline gauze one is packing it wide open. One is certainly packing it wide open for drainage and it does not seem important whether one puts a case around it or not in so far as the anaerobic infection is concerned.

#### FRACTURE OF BOTH FEMORA—UNUSUAL COMPLICATIONS

DR PAUL MECRAY and DR I E DEIBERT reported the case of a woman in whom there had been a fracture of both femora with delayed union, who after open operation on one bone showed an apparent tendency to form callus more rapidly. This was complicated by the formation of multiple renal calculi, disappearing spontaneously after fracture healing, suggesting a disturbance in calcium metabolism.

The patient, twenty-one years of age, was admitted to the Cooper Hospital, of Camden, N J, May 31, 1930, having been in an automobile accident the previous evening. X-ray examination showed a transverse fracture of the right femur about five inches below the trochanter and a transverse fracture of the left femur about six inches above the condyles.

## FRACTURE OF BOTH FEMORA—UNUSUAL COMPLICATIONS

On the morning of admission the patient was given nitrous-oxide anaesthesia and ice tongs were applied to the condyles of both femora, Thomas splints with the Pearson attachment were put in place and swung in the Balkan frame in the usual manner. During the following six weeks frequent X-ray films were made, the apparatus was constantly adjusted in order to maintain the proper alignment, the patient was quite ill and never very comfortable, but aside from the usual difficulty that one would experience in the management of fractures of this type no complications developed. At six weeks, X-ray showed the position of both fractures to be very satisfactory. At eight weeks, the extension was removed. A few hours following, marked deformity of the left thigh was observed and subsequent X-ray showed a posterior displacement of the lower fragment, there was considerable mobility of the fragments clinically. All laboratory examinations were negative, the blood calcium was 12 milligrams per 100 cubic centimetres of blood serum.

Two months after admission the patient was given spinal anaesthesia, and the fracture site of the left femur exposed, practically no callus was present and there was beginning eburnation of the fragment ends. The area was cleansed, ends of the bones were freshened and a six-screw Lane plate applied to the fracture site. Wound closure was made in the usual manner and a plaster spica applied, the patient making a good operative recovery. At eight weeks all extension apparatus was removed, operative wound entirely healed, X-ray showing the alignment of both bones to be very satisfactory with callus in large amounts.

Ten days following the removal of the extension, or about nine weeks after the operative procedure, the patient complained of a severe pain in the right loin and suffered a rigor, followed immediately by the passage of two small stones in the urine. Laboratory examination proved these stones to be of the calcium oxalate variety. X-ray showed that there were numerous small stones in the pelves of both kidneys and in the right ureter, the left ureter was apparently clear. This was confirmed by ureteral catheterization and pyelogram. The pain and fever continued, there was considerable tenderness and swelling in the right flank posteriorly and on November 4, a right perirenal abscess was incised and drained, culture showing colon bacillus. Following this procedure the pain and temperature disappeared and the patient was a great deal more comfortable, the general condition improved, the temperature remained slightly elevated and slight pain in the right loin was occasionally complained of.

December 9, 1930, the patient was again cystoscoped and ureteral catheters passed and the pelves irrigated, which seemed to add considerably to the comfort of the patient. Eleven days later she passed a small stone about the size of a pea. X-rays prior to the cystoscopy had shown these stones attempting to pass down the ureter. Following the passage of this stone the patient made a rapid and uneventful recovery and was discharged from the hospital January 4, 1931. She has remained in perfect health.

DOCTOR McCRAE said he reported this case as having unusual complications because of the large number of calculi and the fact that they were passed when the patient got on her feet. Renal calculi occur more often as a complication of severe fractures that keep the patient in a prone position for a longer time than is commonly supposed. We know they are seen in spinal fractures, but here, too, many of them would be overlooked but for the reason that they are shown incidentally on a film aimed at the spine.

## PROBLEM OF DELAYED UNION AND UNUNITED FRACTURE

DR HUBLEY R OWEN pronounced the annual address on the above entitled subject for which see page 759

DR ELDRIDGE ELIASON remarked as to the definition as to what constitutes an ununited fracture We used to think delayed union meant six weeks without solid union and that non-union meant twelve weeks without solid union Today we know that is entirely too short a time for such a decision For example, Doctor Owen mentions two children in the series whose injuries were considered as non-union or ununited fractures—one at the end of two and one at the end of three and a half months The speaker recalled one case of his own in which both bones of the forearm were ununited for eighteen months and then after six weeks at the seashore in the air and sunlight, solid union was obtained The causes of non-union, as Doctor Owen brought out, are local and constitutional Among the constitutional causes, as well as the local causes of pathological fracture, for example, of which many result in non-union, only one or two constitutional diseases figure For example, fractures of tabetic origin never unite The local causes for non-union in pathological fractures are only four Out of thirty causes of non-union, twenty-six have union in from 25 per cent to 100 per cent Sarcoma, endothelioma, multiple myeloma and hypernephroma show no records in the literature of having united We can disregard or put in the background the constitutional causes unless we require an alibi The local causes of non-union are pretty well defined faulty fixation, faulty approximation, faulty blood supply We also notice three major local sites in the body for non-union in the shafts of the bone, this excludes short bones and articular fractures, especially fractures of the neck of the femur These local sites are, lower end of both bones of the leg, tibia, fibula, the upper limitation of the lower fourth of the radius and the middle of the shaft of the humerus All of these are interesting from the standpoint that one or more of the three causes are certainly responsible, *viz*, faulty fixation, faulty approximation, or faulty blood supply Faulty fixation is open to question The fact that ribs and clavicles unite although they are moved with every respiration indicates this may be a provision of nature at these two sites Faulty approximation is extremely important, not only with reference to the time elapsed before approximation is accomplished, but also with regard to the number of attempts made to accomplish a satisfactory approximation We know, for example, that comminuted fractures rarely, uncomplicated by infection, are the site of non-union, but repeated attempts at reduction have a tendency to interfere with the solid union Doctor Owen brought out the point that early treatment, *i e*, emergency treatment of a fracture, is essential because the earlier the surgeon gets the case the easier it is to reduce, the easier it is to hold in position, and the less often does one have to attempt to put it in position Frequent attempts at reduction increase complication A fracture should be handled and treated by an individual, not by five or six

The man who treated it in the beginning should handle it throughout, and for that reason in the University of Pennsylvania Hospital the assistant on each service is notified when a fracture is brought into the hospital. It is taken immediately to the fluoroscopical room and the reduction is accomplished. The assistant, with an experience of two, three or four years, or the chief, then supervises the reduction under the fluoroscope, permitting the interne to do the actual work when advisable. The results have been very interesting. Ten years ago only 7 per cent were reduced under twelve hours after admission. Between the years of 1925 and 1928, when the fluoroscope began to be used satisfactorily, reduction was increased to 43 per cent, and between 1930 and 1931, satisfactory reduction under the fluoroscope together with the above-stated régime of experienced supervision was increased to 80 per cent. That meant 80 per cent of the cases that came in had a definite permanent reduction in from an hour to an hour and a half after the case was admitted. That meant that many of those cases could go out the next day, that the films were reduced from twelve per patient to three, that the expense of the X-ray department was reduced approximately 60 per cent. What effect has that on the patient's union? Simply this. In the last ten years at the University of Pennsylvania Hospital cases of shaft fractures followed up on shafts of the bone treated there showed that only two-tenths of 1 per cent resulted in non-union. According to Groves and others—as stated by the essayist—this figure ranges from 5 to 4 and 5 per cent, so that attention to these cases, treating them as emergencies by individuals, with the proper supervision, has produced better results. The after-treatment as mentioned by the writer is very important. Blood supply likewise is extremely important for the union of a fracture. If you do not have blood supply, you cannot have union, and blood supply depends largely on activity. Which is the best way to get it? The physiotherapy given by the patient, together with aided active motion is the best. *Make him responsible.* Impress upon him that he must work out his own salvation.

# BRIEF COMMUNICATIONS

## INGESTED RIFLE BULLET REMOVED FROM THE URINARY BLADDER

THE following case is reported as a contribution to the unusual and, sometimes, almost unbelievable performances of foreign bodies which have entered the human system

M S A, a soldier, came under my observation in February, 1920, while I was chief of the surgical service at the Station Hospital at Camp Meade, Md. He stated that in August, 1919, he stumbled while going down stairs and accidentally swallowed a rifle bullet which he was holding in his mouth, and that following the swallowing of the bullet various sequelæ followed without the bullet being passed. The reason for admission to the hospital was on account of some blood in the urine and also pain at the end of micturition. The soldier was very carefully questioned as it was felt that he was mistaken about passing the bullet, but he was very insistent that it had never passed as he had carefully examined all his stools since the time when he had swallowed the bullet. At first it was not suspected that there might be some relationship between his complaint on admission and the ingestion of the bullet, and it was not until a careful physical examination had been made and an X-ray taken that much credence was given to his story.



FIG 1—Shows bullet as removed at operation. The deposit of salts which covered the base of the bullet was broken during removal but the ogive end shows the characteristic appearance of the bullet at the time of operation and also as it appeared on the cystoscopical examination.

The history showed that about three weeks after the accidental ingestion he began to have pain at stool associated later with diarrhœa in which there was some fresh blood. He reported to his regimental infirmary for this condition and was under treatment for about ten days, after which time the diarrhœa and the pain which he had had on defecation cleared up. Following this he felt perfectly well and had no further trouble for about three months, after which time he noticed that there was considerable blood in his urine and also that he had pain on micturition. The hæmaturia gradually cleared up but the pain at end of micturition persisted. An X-ray revealed a rifle bullet in the pubic region and apparently lying within the bladder. Cystoscopical examination showed a salt-encrusted rifle bullet adherent to the posterior wall of the bladder.

March 8, 1920, the bladder was opened through a suprapubic incision. The bullet could be seen adherent to the posterior wall of the bladder, and was removed. It was completely covered by a deposit of salts, which had, however, not changed the contour of the foreign body, some of this calcareous covering became broken while the bullet was being removed (Fig 1). The deposit on the anterior aspect of the bullet was considerably thicker than on the posterior surface which was in contact with and adherent to the bladder wall, the deposit at this point being very thin and in places practically absent. At the site from which the bullet was removed there was a small scar, but whether this was the result of the bullet entering the bladder at this point or was the result of the contact of the foreign body with the bladder wall could not be determined. No sinus was found in the bladder wall.

At first the possibility of an ingested rifle bullet passing into the bladder seemed rather far-fetched, but the history in this case was so clear and the

## INGESTED BULLET IN BLADDER

chronological sequence of events so significant that this possibility could not be discarded, the more especially when one considers the anatomy of the region, which must have of necessity been traversed by the bullet in order to have given rise to the chain of symptoms which followed the swallowing of the bullet

Anatomically, there is an area where the rectum and the urinary bladder lie in close approximation to each other (Fig 2) The area is limited above by the reflection of the peritoneum over the posterior superior portion of the bladder, the retrovesical fold, below by the prostate, while the anterior rectal wall and the posterior wall of the bladder are separated by the posterior periprostatic (Denonvilliers') fascia There is, therefore, an area where the rectum and the bladder are closely approximated but are separated by a space which is entirely extraperitoneal If, therefore, a foreign body of the

shape of a sharp-pointed rifle bullet should come down through the rectum in such a way as to engage the point on one of the transverse folds or plicæ recti, the point might hold and prevent the bullet from being passed Successive stools would tend to cause the bullet to penetrate farther through the walls of the rectum It was probably this condition of affairs which gave rise to the initial symptoms namely, pain on defecation and blood in the stools Later, after the bullet had penetrated through the wall of the rectum and had entered into the extraperitoneal space between the rectum and the bladder, the symptoms subsided and a period of quiescence ensued Again, at a later

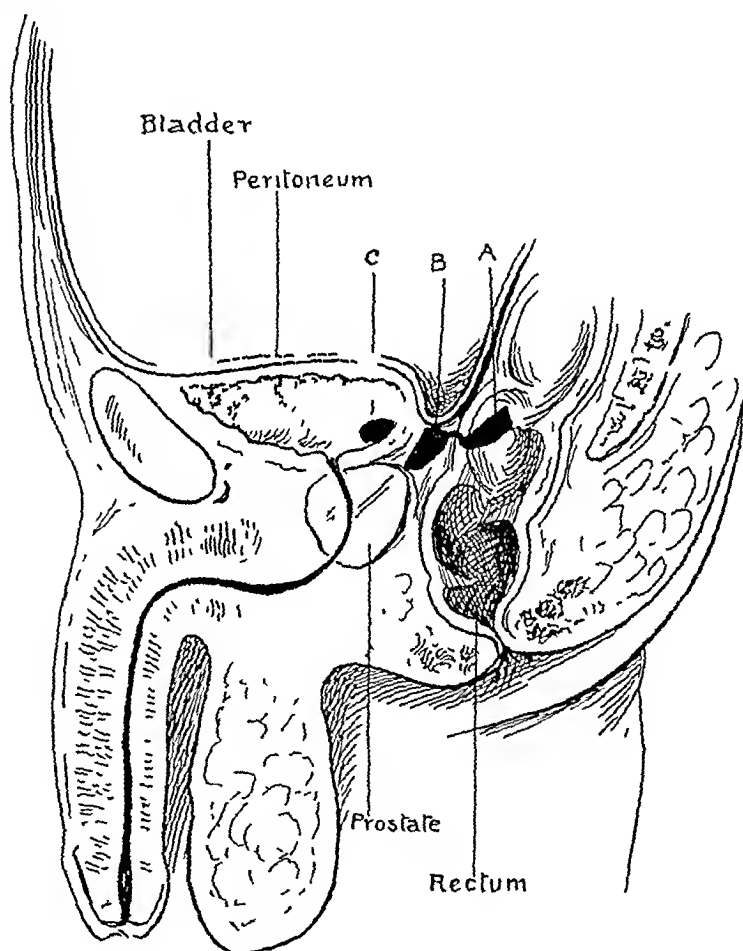


FIG 2—Diagrammatic representation of the course taken by the bullet as described in the text A—First phase represented by pain on defecation and by bloody stools Bullet caught in mucosa and gradually eroding through the wall B—Second phase or period of quiescence Bullet is lying in the extra peritoneal space above the prostate and below the retrovesical peritoneal fold Bullet entirely extra peritoneal and giving rise to no symptoms C—Third phase Bullet has eroded through the posterior bladder wall and is causing pain on micturition and also hematuria Bullet found in this location on cystoscopic examination, and on supra pubic cystotomy

period, the erosion through the bladder wall caused a new chain of symptoms which were manifested by hæmaturia and by pain on micturition

It was following this last manifestation, and especially the pain on



micturition, which caused his admission to hospital for observation, at which time the bullet was found and removed. The convalescence was uneventful, there were no further symptoms and the soldier was returned to duty May 18, 1920.

Several points present themselves for discussion in this case. (1) The possibility of this bullet having been introduced into the bladder through the urethra. The train of symptoms following the ingestion of the bullet were so clear that there did not appear to be any doubt as to the route traversed by the bullet, and furthermore, I doubt if an ogive-shaped bullet of calibre 30, the base of which has the same diameter as a 24 French sound, could be introduced into the bladder through the urethra. If introduced base up the square end would catch on the urethra, and furthermore would probably be blocked when the posterior urethra was reached. If introduced point first the sharp ogive tip would be liable to engage at several points along the urethra and also probably at the membranous urethra and thus prevent further progress. The fact that the bullet was adherent to the wall of the bladder strengthens the theory that the bullet entered the bladder by the route described. If the bullet had been introduced into the bladder through the urethra it would in all probability have been found lying free in the bladder instead of being adherent to the bladder wall.

(2) The slow penetration of the bullet through the rectal wall and then through the bladder wall probably accounts for the apparent lack of extravasation as healing would take place as the bullet passed along. Rapid entrance, however, does not necessarily cause extravasation as was shown in a case I reported in 1916 in which a soldier was wounded by a shrapnel bullet, the bullet passing through the sacrum, around the rectum and then into the bladder and not giving rise to any symptoms.<sup>1</sup>

(3) The lack of constitutional signs in this patient was due to the fact that there was no extravasation and that the course taken by the bullet in passing from the rectum to the bladder was entirely extraperitoneal and the healing occurred as the bullet passed along thus precluding any sinus formation.

(4) It is realized that the evidence as far as ingestion of the bullet is concerned is circumstantial, but the sequence of events appears to be of such a nature that they could not be manufactured by anyone not conversant with anatomy, and for this reason we cannot disprove the fact that the bullet was probably ingested and took the course as has been described.

DUNLAP P. PENHALLOW, M.D.,  
*Washington, D.C.*

## DUCK BONE IMPACTED IN LOWER END OF ŒSOPHAGUS EROSION OF ŒSOPHAGEAL WALL FATAL HÆMORRHAGE

CASE—M. G., a single man, aged forty-three years, was first seen November 3, 1930, complaining of pain in lower chest and epigastrium since he had swallowed a duck bone four days before.

## DUCK BONE IMPACTED IN ŒSOPHAGUS

He remembered distinctly swallowing the bone, and described it as one or one and one-half inches in length. Immediately afterward there was sharp retrosternal pain which radiated to the right axilla and back. Since that time he had continued to notice sharp pain on swallowing definitely located as posterior to the lower third of the sternum, sometimes radiating to the right chest. He had not consulted a physician and had had no treatment.

November 3, just before being seen, he vomited a small amount of light reddish blood. He had had no previous medical care for this illness.

*Examination* showed a well-developed man, not acutely ill, apparently lying in bed in some discomfort and restlessness.

He was seen again at 7 P.M. There had been no further bleeding, but as he had passed a somewhat restless day, and was uneasy, he was taken to Harper Hospital. On

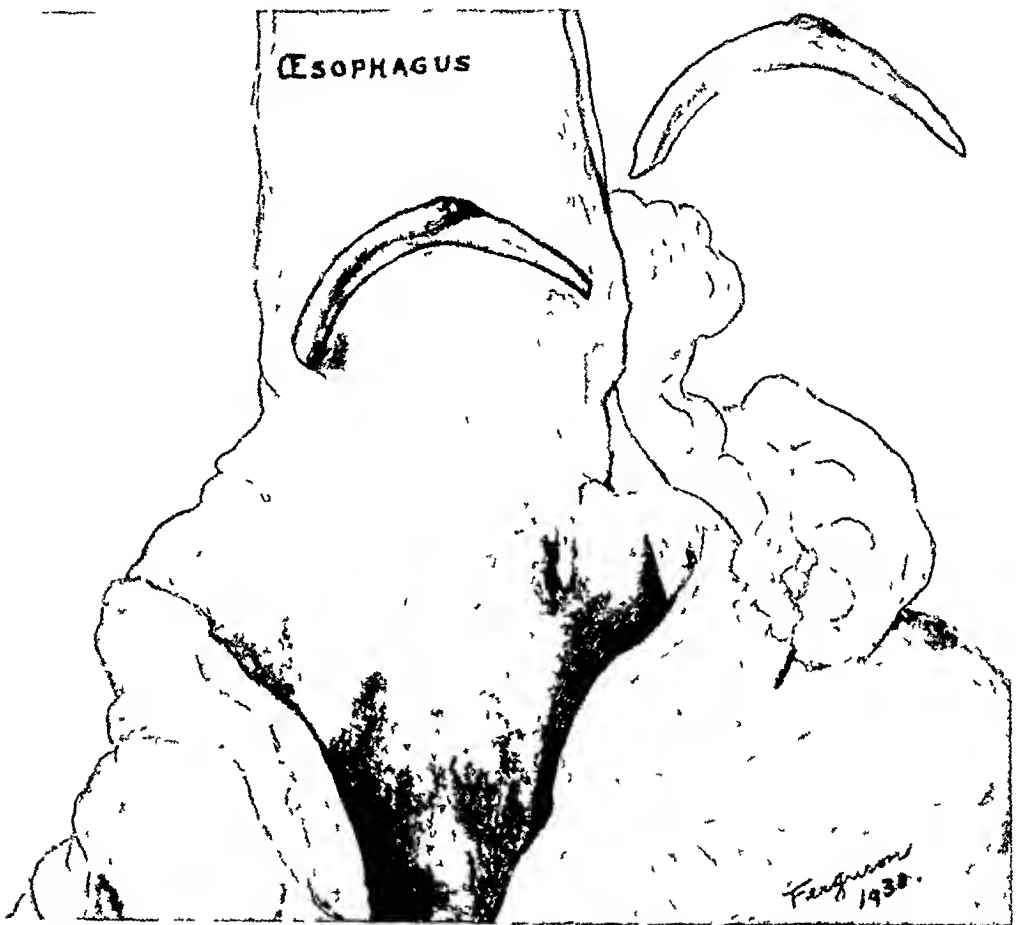


FIG. 1.—Duck bone impacted in lower end of œsophagus causing fatal hemorrhage from vessels in wall of œsophagus.

admission, he complained of considerable pain in the lower chest, costal margin area. He could swallow liquids, but solids went down with difficulty.

At 3 A.M. he vomited about 500 cubic centimetres of clotted blood streaked with bright red blood. The pulse went to 100, but the patient's general condition remained unchanged. At 8 A.M. temperature was 98.6°, pulse 96, respiration 20. At 8.30 A.M. he vomited 500 cubic centimetres of dark blood streaked with bright red, became pulseless for fifteen minutes, but responded well to 500 cubic centimetres intravenous glucose. At 10.30 A.M. 300 cubic centimetres more were given intravenously and the general condition improved slightly. At 11 A.M. the pulse became weak and the respirations more labored and at 12 noon the patient expired.

*Post-mortem* (Dr G. S. Bates).—The stomach was removed intact together with 6 centimetres of the lower œsophagus and all of the duodenum. When opened about 800 cubic centimetres of dark blood, mostly clotted, escaped from the stomach. Among the

clots was found a bone shaped like a boomerang,  $5\frac{1}{2}$  centimetres in length, 5 millimetres wide at its centre, and 2 millimetres thick (Fig 1) One end was sharply pointed and the other more blunt, but with a sharp edge There was no free blood in the œsophagus Three centimetres above the sphincter cardia were two puncture wounds at the same level in the œsophageal wall, 2 centimetres apart (measured on the opened contracted œsophagus) Both wounds extended through the submucosa into, but not through, the muscular coat of the œsophagus There were small submucous and intramuscular hæmorrhages at each point, and a longitudinal blood-vessel could be seen coursing directly beneath the mucosa in close proximity to one of these wounds The ends of the bone found free in the stomach seemed to fit exactly into these puncture marks At the gastric edge of the sphincter was a small irregular laceration of the mucosa, 3 millimetres long There were no other lesions of the mucosa to be found in the œsophagus, stomach or duodenum Death had been due to hæmorrhage from the lower portion of the œsophagus, following trauma to its wall by the ingested foreign body

The impaction of a foreign body in the supradiaphragmatic portion of the œsophagus is unusual Chevalier Jackson states "Almost all foreign bodies are arrested in the cervical œsophagus at the level of the superior aperture of the thorax (below the cricopharyngeal or first constriction, and corresponding with the seventh cervical or first dorsal vertebra) If dislodged from this position the foreign body usually passes downward to be arrested at the next (aortic) narrowing (level fourth thoracic vertebra) or to pass into the stomach"

St Clair Thomsen plotted the location of 135 reported foreign bodies in the œsophagus The chart shows four lodgements below the seventh dorsal vertebræ in cases in which the site was stated exactly, and eight localizations in this region where "the localization was given in more general terms" "The grouping of almost all the cases in the upper third of the œsophagus is very striking and coincides with the experience of all œsophagoscopists Most of the very few cases of lower lodgement encountered have been pushed down by blind methods"

Similarly, in Gittins' recent report of thirty-six foreign bodies in the œsophagus, twenty-four were lodged in the upper third, seven in the middle third, and one in the lower third

Just why foreign bodies usually lodge at the level of the superior thoracic aperture is not quite clear This is not one of the well-defined anatomical narrowings of the œsophagus Jackson's opinion is that in addition to there being a physiological narrowing here due partly to spasm, there is also (and more important) the fact that the cervical œsophagus is a collapsed tube surrounded by more powerful muscles, while the mediastinal œsophagus is constantly being pulled open by the negative intrathoracic pressure Hence, once a foreign body passes the thoracic aperture, unless of unusual size or shape, it tends to be relieved and finds its way downward

The termination by fatal hæmorrhage apparently from a vessel in the wall of the œsophagus is also unusual

Most fatal terminations from foreign bodies in the œsophagus are due to perforation of its wall, causing mediastinitis, lung suppurations, gangrene, *etc*, or perforation into a large adjacent blood-vessel, usually the aorta It is not common to find record of a death due to hæmorrhage from a vessel

## DIVERTICULA OF ŒSOPHAGUS

in the wall of the œsophagus caused by penetration of a foreign body Poulet, in 1880, listed thirty-three reports of fatal hæmorrhages from perforations of the œsophagus and blood-vessels There was only one among them due to rupture of an œsophageal artery His list follows Aorta, 17, carotid left and right, 3, superior vena cava, 2, inferior thyroid, 1, right coronary vein, 1, hemiazygos vein, 1, right subclavian vein, 1, œsophageal artery, 1, pulmonary artery, 1, unknown arteries, 4

In our case, the foreign body was found in the stomach However, the erosions in the wall of the œsophagus corresponded exactly with the sharp ends of the bone Though the lesion was small, a superficial blood-vessel coursed directly beneath the œsophageal mucosa in close proximity to it In this connection it is well known that many ulcers of the stomach and duodenum which bleed fatally are small, frequently no larger than the head of a pin

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## DIVERTICULA OF ŒSOPHAGUS

I NOTE in the January issue of the ANNALS OF SURGERY (p 153), under the Transactions of the New York Surgical Society, a discussion concerning diverticula of the œsophagus in which I am quoted by Dr Franz Torek, and I am writing to correct a statement by Doctor Torek which is unintentionally wrong

There will always be a difference of opinion as to the best way to do things and it is desirable that this should always be present, as it accomplishes progress I wish however to correct the impression given by Doctor Torek that the reason I advised passing bougies post-operatively following the two-stage operation for œsophageal diverticulum was that there were post-operative strictures I advise passing of bougies post-operatively because of the fact that the constriction of the crico-pharyngeal fibres which have to do with

the original production of the lesion is still present and if one would be logical in preventing further recurrence of a sac through the weak point in the posterior wall of the pharynx at the pharyngo-œsophageal junction, then some attempt, I think, should be made to dilate these fibres and to overcome any possible spasm in them. This is the reason why post-operative dilatation has been practiced and advised in these cases.

The name "pinchcock muscle" applied to the crico-pharyngeal muscle, as the cause of pulsion diverticulum, was suggested by Dr. Chevalier Jackson, in whose clinic the one-stage operation is practiced. If there is a pinchcock effect before operation, there still is after operation by either the one- or two-stage operation and post-operative dilatation is necessary with either operative procedure.

There have been no cases of stricture and I do not believe that with the two-stage operation there is any real danger of stricture. There will, it seems to me, be a greater danger of stricture formation with the one-stage operation than with the two-stage, since in the one-stage operation one could easily remove too much œsophagus. The real danger in the two-stage operation is not that too much sac is removed but that not enough is removed.

It seems to me that Doctor Pool has stated the situation quite correctly as far as our views go. We have now operated upon thirty-three pulsion œsophageal diverticula with no fatality, many in very aged people, all of whom are swallowing quite satisfactorily. After all, the important thing with this lesion is safety, and if mediastinitis occurs after primary suture in the one-stage removal, there is very little that can be done about it. The two-stage removal is so safe and so satisfactory that I would personally feel that even if one patient in a hundred died of the one-stage and did not die with the two-stage, the two-stage would be my operation of choice.

FRANK H. LAHEY, M.D.,  
*Boston, Mass.*

# MEMOIR

## HARRY CLAY DEEVER, M D.

1861-1931

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DR HARRY CLAY DEEVER was born July 23, 1861, in Buck, Lancaster County, Pennsylvania. His father was a general practitioner covering a large territory about this small crossroads hamlet. He had three brothers, two of whom studied medicine. The oldest, Richard, became a successful



HARRY CLAY DEEVER, M D

general practitioner in Germantown, Pennsylvania, John B. Deever became an internationally known surgeon.

Dr. Harry Deever was graduated from the University of Pennsylvania in 1885 and served as resident physician in the Episcopal Hospital, Philadelphia,

from April 1, 1886, to December 1, 1887. He was at once elected Dispensary Surgeon to that institution and in October, 1892, was made Visiting Surgeon which position he held until his death. In 1892 he was also made Attending Surgeon to St. Christopher's Hospital for Children, holding this position until 1908 when he retired to become Consultant. He served also as Surgeon-in-Chief of the Children's Hospital of the Mary J. Drexel Home from 1901 to 1931. From 1909 to 1922 he was Professor of the Principles and Practice of Surgery and Clinical Surgery of the Women's Medical College of Pennsylvania. He became a Fellow of the American Surgical Association in 1912. Doctor Deaver, while not so widely known as his brother John, enjoyed a very considerable local reputation and carried on a large practice throughout his life. He always kept a small proportion of general practice, chiefly among friends whom he had accumulated in the early period of his career. He liked these contacts and his brother John always maintained that it made him a better surgeon. However, the bulk of his work was surgical and was characterized by sound judgment, conservatism and thorough mastery of surgical technic. Had he chosen to write and speak to a larger public, there is no doubt that he could have achieved wide reputation. He preferred, however, a more secluded life and the well-merited confidence of his associates which he enjoyed. He died June 25, 1931, at his home in Wyncote, Pennsylvania, from cardiorenal complications following an attack of influenza.

DAMON B. PREIFFER

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# ANNALS *of* SURGERY

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## ACUTE INTESTINAL OBSTRUCTION

AN ANALYSIS OF TWO HUNDRED AND SIXTY-SIX CASES TREATED IN THE  
LOS ANGELES COUNTY GENERAL HOSPITAL \*

By I JACK VIDGOFF, M D

OF LOS ANGELES, CAL

FROM THE SURGICAL SERVICE OF THE LOS ANGELES COUNTY GENERAL HOSPITAL

VERY little progress has been made in the last forty years in reducing the mortality of acute intestinal obstruction. In 1888, acute intestinal obstruction was a major subject of discussion at the American Association of Physicians and Surgeons. At that time the average mortality was 40 to 60 per cent. Twenty-five years later, acute intestinal obstruction was again discussed at the first annual session at the American College of Surgeons, the average mortality still being 40 to 60 per cent. Recent contributions still show the mortality to be practically unchanged, ranging from 36 per cent in a series of cases by Finney<sup>1</sup> in 1921, to that of 60.9 per cent in a series described by Miller<sup>2</sup> in 1929.

In spite of recently acquired laboratory aids and advanced diagnostic ability, we still lose approximately one-half of all patients having acute intestinal obstruction. This fact was the stimulation for undertaking this study of 266 cases. This report includes all cases of acute mechanical obstruction during the period of July, 1925, to July, 1930, which were admitted to the Los Angeles County General Hospital. The survey includes only definitely proven cases of acute mechanical obstruction, excluding adynamic ileus and cases of incarcerated hernia in which the bowel was not definitely occluded.

It must be remembered that these cases were usually seen by the family or neighborhood physician first, who referred 90 per cent of these cases into the hospital. As a result, most cases have had a trial of "watchful waiting," and were sent into the hospital when an enema failed to return gas or fecal material. My purpose is not to discredit the family physician, for the delay is not his fault, as a rule. Many times it is the patient himself who refuses surgery, thinking that the condition is merely a "stomach-ache" and that a cathartic or an enema or some family remedy will bring relief. It is also often difficult for the family physician to make up his mind that a pain in the abdomen is the result of an intestinal obstruction. The picture is not always typical and many fatal cases were under observation by the surgeon after the patient was admitted to the hospital. Only when we realize that these cases should be operated upon even on suspicion will the mortality be reduced.

\* Read before the Surgical Staff of the Los Angeles County General Hospital, May 25, 1931.



It is interesting to note that 10 per cent of the cases developed intestinal obstruction while under observation in the various wards of the hospital, and that the mortality of this group of cases was 10 per cent higher than the general mortality. This further emphasizes the fact that it is not the fault alone of the family physician. There must be cooperation between the patient, the internist, and the surgeon. Even while the patient is observed in the ward there is still a tendency to procrastinate. The dictum of "sit tight" kills as many patients with intestinal obstruction as does morphine and cathartics.

*Incidence*—There was one case of intestinal obstruction to practically every 400 patients admitted to the hospital during the five-year period. During this period there were 266 cases of acute intestinal obstruction with 122 deaths, an average mortality of 45.9 per cent.

In 1926 there were thirty-six cases with mortality of 33 per cent.

In 1927 there were forty-four cases with mortality of 55 per cent.

In 1928 there were seventy-eight cases with mortality of 36 per cent.

In 1929 there were sixty-six cases with mortality of 24.8 per cent.

In the half years of 1925 and that of 1930 there were forty-two cases with a mortality of 66 per cent. Because our medical audit department began their year in July, it was necessary to take the cases accordingly. However, should the fiscal year be considered, our mortality has been gradually reduced to 25 per cent in 1929.

*Factors Influencing Mortality—The Incidence of Sex and Age*—In this series, 47 per cent of the patients were males with a mortality of 37.5 per cent, and 53 per cent were females with a mortality of 44 per cent. The reason for the slightly larger percentage of females is probably due to the large amount of surgery done on the female generative organs with consequent adhesions. The ages varied from two days to eighty-one years. The average age recovered was 33.9 years while the average age died was 49.4 years. Sixty per cent of the patients were between the ages of twenty to fifty years.

*Days in the Hospital*—The average days in the hospital was 30.6 days for those who recovered and 5.1 days for those who died. This indicates that if the patient does not recover from intestinal obstruction, he usually succumbs in a short time. This has been observed frequently, many patients dying suddenly on the third or fourth post-operative day. The exact cause of this rather sudden death observed in these cases is not known. It was thought that it might be due to pulmonary embolism because of the manner of death, yet none of the cases coming to autopsy revealed any evidence of this lesion. It was also thought to be due to the sudden absorption of the toxic substances in the bowel after the obstruction was released. This, however, has been denied by many investigators.

*Time of Onset*—The average length of time of onset of symptoms before the patient was admitted into the hospital was 2.6 days. This had a great influence on the high mortality. In 110 cases the onset was less than two days with 64 per cent recovery. In 156 cases the onset was over two days

with 44 per cent recovery—a difference of 20 per cent. The shortest interval between the onset of symptoms and operation was seven hours. The shorter the interval the better is the chance for recovery. Finney had twenty-one cases which were operated within twelve hours or less with a mortality of 5 per cent. In the second twelve hours the mortality was 11 per cent, and in the second twenty-four hours it was 31 per cent. These statistics alone give us the reason for our large mortality rates and clearly show what Finney meant when he said, "Early diagnosis is the most important factor in the whole category."

*Symptoms and Signs*—The clinical picture of intestinal obstruction is not as clear as text-book descriptions would imply. The symptoms depend upon the portion of the bowel involved. Generally speaking, the higher the obstruction, the more severe the symptoms and the graver the prognosis. The most common symptom and the one present in practically every case was abdominal pain. The pain associated with small bowel obstruction was paroxysmal, cramping, or knife-like and was associated with vigorous peristalsis. The pain associated with large bowel obstruction was less severe and less intermittent in character. During the paroxysm, the patient is usually doubled up and attempts to limit intestinal movement by limiting his respiration and by pressure of the hand on the abdomen. The pain is usually relieved by morphine. The pain is due to spasm of the smooth muscle and to the peristaltic effort on the part of the bowel to overcome the resistance at the point of obstruction.

Vomiting was present in 95 per cent of the cases. Fæcal vomiting was observed in 13.6 per cent of the patients with a mortality of 75 per cent. The higher the obstruction, the earlier the vomiting appeared. In low bowel obstruction, vomiting was a late symptom. The vomiting was not associated with the taking of food, and occurred, as a rule, with the paroxysms of pain. The exact cause of the vomiting is not known but its results have caused considerable discussion in regard to the acid-base equilibrium of the body. A majority of the observers agree that it accounts for the greater part of the dehydration, but are less prone to attribute the alkalosis which is present, at times, to the loss of the fluids.

Constipation was present in 60 per cent of the cases. Diarrhœa was present in 8 per cent of the cases. In 20 per cent of the cases enemas had produced results, that is, a return of either fæcal matter or flatus. This is due to the fact that the bowel below the obstruction usually acts in a normal manner and may empty its contents. Once the bowel below the obstruction is empty, constipation is absolute. This absolute constipation, with pain and vomiting, form a triad of symptoms which should immediately put one on his guard and suspect intestinal obstruction.

Distension of the abdomen was present in 45 per cent of the cases. Fever was absent as a rule. An elevation of temperature as observed in this series usually indicated either a peritonitis or pelvic abscess.

Rigidity of the abdominal muscles, as a rule, was absent. Instead, the abdomen was doughy and the coils of distended bowel could be palpated.

Visible peristalsis was reported in only 5 per cent of the cases, and was usually a late sign. Tenderness was present only in complicated cases and was associated with rigidity and temperature.

The average white cell count was 7900 with 79 per cent polymorphonuclears. The counts averaged from 5400 to 28,000. The leucopenia is the rule because of the toxæmia. Leucocytosis was found in late cases or in complicated cases due to a peritonitis.

Judging from the histories written by the surgical internes, intestinal obstruction could be diagnosed in over 80 per cent of the cases. In some, a definite diagnosis was arrived at only with considerable difficulty. The other conditions with which intestinal obstruction may be confused are usually surgical, and the fact that a definite diagnosis is not made, should not deprive the patient the benefit of an immediate laparotomy. If there is sufficient reason to suspect the presence of an intestinal obstruction, waiting for the complete classical picture is unwarranted.

*Previous Operations*—An interesting finding was the relative high percentage of cases which had previous abdominal or pelvic operations. In Miller's series 24.2 per cent of the cases had had previous operations, and in Finney's series, 40 per cent of the cases presented abdominal scars. In this series 68 per cent had had previous abdominal operations. It was interesting to note the difference in mortality in those patients with previous abdominal operations as compared to those who had none. In 32 per cent of cases not having previous abdominal operations, there was a mortality of 61.2 per cent, over 15 per cent greater than the average mortality. This can be accounted for largely by the fact that obstruction was suspected sooner in the presence of an abdominal scar, again indicating, perhaps indirectly, the value of early diagnosis. The reason for the high mortality in cases without previous operations is also due to the fact that most of the cases were either carcinoma, which carried a high mortality on its own accord, or were unsuspected internal hernias. The latter were usually attended with high-grade and fulminating types of obstruction, more difficult of diagnosis.

A right rectus scar was most commonly observed. This was found in seventy-eight cases or 29.3 per cent of the total number. Of these seventy-eight cases, 44.8 per cent was the result of operations for ruptured appendicitis and had an attendant mortality of 54.3 per cent. This, incidentally, shows the ultimate results of acute appendicitis when not operated early.

A mid-line scar was present in seventy-two cases or approximately twenty-five of the total number. Of these seventy-two cases 62 per cent involved operations on the female pelvic organs, and had a mortality of 42 per cent. In Finney's series the mortality following pelvic conditions was 60 per cent. This indicates how careful one should be in peritonizing all raw areas produced by operations on the pelvic organs in women.

The shortest time interval after the previous operation before the patient became obstructed was five hours. The longest was about twenty-seven years. In twenty-three cases (8.9 per cent) obstruction developed within three weeks after operation. In 9 per cent of the cases there had been

previous operations for intestinal obstruction, the number of operations varying from two to twenty-eight

*Anæsthesia*—It was interesting to note the effect of various anæsthetics in regard to prognosis

79.5 per cent of the cases had ether with mortality of 41 per cent

9.5 per cent of the cases had spinal with mortality of 48 per cent

11.0 per cent of the cases had local with mortality of 89 per cent

These figures are not to be taken as true indications of the relative merits of any type of anæsthetic. The moribund patients were operated under local and there was naturally a higher mortality. Many observers have noted the relatively lower mortality of general anæsthesia as compared to spinal or local. However, recent reports suggest that best results are to be obtained with spinal anæsthesia, and unless absolutely contra-indicated, spinal is the anæsthetic of choice. The average length of time of anæsthesia was one hour.

*The Rôle of the Flat Plate*—The diagnosis was made largely on the basis of the history of the complaint and physical findings. The history is usually the most important factor. When the physical findings were classical it was usually in the later stages of the disease. Recently we have employed the use of the "flat plate" of the abdomen in confirming the diagnosis. The "flat plate" or "scout film" without use of contrast media, was first used by Schwartz in 1911. Case introduced the procedure in this country at about the same time. Recently Rabwin and Carter<sup>3</sup> reported a series of cases at the Los Angeles County General Hospital in which the "flat plate" was instrumental in confirming diagnosis and localizing the obstruction. Many of their cases are included in this series. The procedure is now routine in all cases in which intestinal obstruction is suspected. The actual time spent in preparing the patient and reading the film was about twenty minutes. The patients were given a milk and molasses enema to empty the bowel below the obstruction, and a film was then taken. This procedure causes the patient little if any distress. The film can be developed while the patient is being prepared for surgery, avoiding loss of time. In this series the "flat plate" was taken in 104, or approximately 39 per cent of the cases. Of these the interpretations of the gas shadows lead to a positive diagnosis of intestinal obstruction in 71 per cent. The report as given out by the roentgenologic department was always guarded, stating that the picture was of an ileus, not differentiating it as to mechanical or adynamic.

The report was negative for obstruction in twenty-five cases. All of which were later found at operation to be completely obstructed. The negative findings in most of these cases were due to the fact that the bowel was filled with fluid which could not be seen on the "wet film."

It is evident that the diagnosis is not to be made by the use of the "flat plate" alone. The average case as seen by the family physician should not wait for the "flat plate" to be taken. In large hospitals such as this where X-ray service is available during twenty-four hours of the day, a "wet film" can be taken easily and in many cases is of distinct value. Its greatest value,

however, is not so much as a diagnostic aid but in stimulating the surgeon to operate. If one is not sure of the diagnosis, the typical picture of the distended loops of gas-filled bowel on the film encourages the surgeon to believe that intestinal obstruction is present and urges him to operate immediately.

However, we must impress the average practitioner with the relative importance of the symptoms and signs of intestinal obstruction, rather than burden him with laboratory methods usually not available to him. The man who sees the patient first, usually the family physician, can do most in lowering the mortality of intestinal obstruction. For him the diagnosis must be simplified rather than complicated.

Checking over the histories with positive film reports, it was found that the diagnosis was made from the history and physical findings, and that the X-ray film merely made one more sure of the presence of intestinal obstruction. In scarcely any of the cases did the X-ray reveal anything unsuspected by clinical examination.

*Effect on Blood Chlorides*—A complete blood chemistry was done in forty-six cases. Opinion is divided in regard to the rôle that blood chlorides play in prognosis. In this series the amount of blood chlorides present evidently played no part either in diagnosis nor prognosis. It is certainly unwise to withhold operation awaiting a blood chemistry report or preliminary administration of hypertonic chloride solution. The average blood chlorides in patients with intestinal obstruction who died were 390 milligrams per 100 cubic centimetres of blood. In those who recovered, the blood chlorides averaged 390.6 milligrams. Over one-half of the cases had a blood chloride of 450 milligrams or over. In several cases who died, the blood chlorides were as high as 550 milligrams and yet a high-grade obstruction with gangrene was present. It is interesting to note that the mortality in the cases given hypertonic saline was 65 per cent. This is probably explained by the fact that hypertonic saline was administered in the obviously bad cases. Normal saline was administered by hypodermoclysis in practically every case and was of distinct value in furnishing fluids.

*Causes of Obstruction*—From the accompanying table (Table I) it is seen that the three most common causes of intestinal obstruction in this series were adhesions, hernia, and carcinoma respectively. In infants the most common cause was intussusception.

TABLE I

Type	Cases	Mortality
Adhesions	170	37.6 per cent
Hernia	49	60.0 "
Cancer	22	68.0 "
Gall-stones	4	25.0 "
Intussusception	11	66.0 "
Volvulus of sigmoid	4	75.0 "
Meckel's diverticulum	2	None
Diverticulitis	2	100 "

## ACUTE INTESTINAL OBSTRUCTION

The most frequent single cause of obstruction in this series was adhesions. There were 170 cases of obstruction due to adhesions with 106 recoveries, a mortality of 37.6 per cent. The lowest mortality was found in this group, the reason being that the presence of an abdominal scar usually hastened operation.

The next most common type of obstruction was hernia, forty-nine cases with a mortality of 60 per cent. The general mortality and the mortality of hernia would be much less had incarcerated hernia been included. The high mortality is due to the fact that only strangulated hernia was considered in this series. It is also of interest to note that there were fourteen cases of internal hernia due to congenital malformations with a mortality of but 50 per cent. These included hernia into the retrocæcal fossa,<sup>4</sup> hernia into the paraduodenal fossa, and other hernia due to malrotation of the gastro-intestinal tract. There were thirteen cases of strangulated inguinal hernia with a mortality of 66 per cent. In over one-half of these cases gangrene was present. The other forms of hernia found were femoral hernia with a mortality of 50 per cent, hernia through the obturator foramen, hernia through the broad ligament, ventral hernia, and a case of hernia through a gastro-enterostomy loop.

There were twenty-two cases of carcinoma with fifteen deaths, a mortality of 68 per cent. There were fourteen cases having carcinomas at the recto-sigmoid junction with a mortality of 64 per cent.

A word may be said about the less common causes of intestinal obstruction. There were eleven cases of intussusception with a mortality of 66 per cent. It was interesting to note that there were four cases of obstruction due to gall-stones with but one death. These cases were not toxic as a rule because gas probably escapes around the stone and prevents distension of the bowel and consequent interference with blood supply. The one fatal case died of a small perforation of the bowel with a resultant peritonitis. There were four cases of volvulus of the sigmoid with a 75 per cent mortality, one case dying from another condition rather than obstruction. There were two cases of Meckel's diverticulum producing an obstruction, both recovering. There were also two cases of diverticulitis of the sigmoid with perforation and obstruction, both patients died.

Gangrene of the bowel was present in twenty-nine cases with a mortality of 90 per cent.

*Treatment* Simple release of constricting bands or adhesions was done in 167 cases with a 50 per cent mortality. Resection was done in twenty-nine cases with 80 per cent mortality. In nine of these cases the Murphy button was used with five deaths, and in one case the button was the cause of a re-obstruction twenty-one days after the initial operation. End-to-end anastomosis was done in seven cases with six deaths. The side-to-side anastomosis was done in two cases with one death. The two loops of bowel were brought to the outside without anastomosis in six cases with five deaths. These figures show the

results of late cases of intestinal obstruction, that is, with strangulation and interference of the blood supply to the bowel

TABLE II

Procedure	Cases	Mortality
Release adhesions	167	50.0 per cent
Resection	29	80.0 "
Enterostomies	40	79.8 "
Cæcostomy	10	80.0 "
Colostomy	5	60.0 "
Entero-anastomosis	6	33.0 "
Enterotomy	4	25.0 "
Bowel stripped	5	40.0 "

Enterostomy was done in forty cases with a mortality of 79.8 per cent. This was usually done in late cases of obstruction. Many observers, notably Van Buren and Smith<sup>5</sup> also report high mortalities in cases in which enterostomy was done.

An enterostomy which drains the bowel is of distinct value in some instances. This is true particularly in cases of adynamic ileus rather than those of mechanical obstruction. There were two cases in particular, both children, who developed an adynamic ileus following a perforated appendicitis with peritonitis. Both these children were vomiting faecal matter and were very toxic. In both these cases a loop of bowel was brought into the wound, and the bowel snipped with a scissors. No anaesthetic was necessary, the procedure being carried out in the ward. Drainage was thereby established and the patients improved immediately. In one case the loop of bowel opened proved to be the jejunum, and the liquids taken by mouth would drain through the fistula. The child was not given fluids by mouth and after a rest period of four days the fistula healed completely of its own accord. Fluids were supplied by rectum, under the skin, and by the intravenous route. In the other child the loop of bowel opened was the ileum, and in this case complete healing did not occur so soon.

Unfortunately most enterostomies which are done in mechanical obstruction do not drain the bowel, and the catheters which are sutured into the bowel are either pulled out by the patients, or kink the bowel in such a way that there is practically no drainage. It is far better to operate these patients and release the obstruction, emptying the bowel immediately rather than inserting a tube and hope that it will produce drainage. Of course in extremely moribund patients there is nothing to do but to open the bowel and in these cases it is better to bring the loop of bowel to the wound and suture it there and then cut it, rather than use a catheter.

Cæcostomy was done in ten cases with a mortality of 80 per cent. Colostomy was done in five cases with 60 per cent mortality. These were done in cases of carcinoma of the large bowel. Five of these patients survived the first stage, but died after the removal of the growth.

Entero-anastomosis, short-circuiting loops of bowel, was done in six cases with a mortality of 33 per cent. Enterotomy was done in four cases with

## ACUTE INTESTINAL OBSTRUCTION

one death. The bowel was drained according to the Holden<sup>6</sup> technic in five cases with two deaths.

It is important in considering the treatment to differentiate incarceration from strangulation. When incarceration is present the patient is not toxic as a rule, and simple releasing of adhesions or short-circuiting operations may be all that is necessary. However, when there is distension of the bowel with consequent interference with the blood supply, and damaged intestinal mucosa, there is absorption of toxic contents of the bowel with resulting toxæmia. In these latter cases it is far better to drain the bowel of its contents, for simply releasing the obstruction will not relieve the patient.

### SUMMARY

(1) The mortality of intestinal obstruction can only be reduced when it is recognized early and operated early. The patient is often as much at fault as the physician and the surgeon, and greater cooperation between all three is necessary.

(2) The clinical picture is not always clear, and operation should not only be advised but insisted upon on suspicion that intestinal obstruction is present. To wait for the full clinical picture to develop will greatly reduce the patient's chances for recovery.

(3) The commonest cause of obstruction was adhesions. To eliminate these cases it is necessary to operate for acute appendicitis early and to fully peritonealize raw areas in pelvic operations.

(4) The "flat plate" while it is a distinct aid in urging the surgeon to operate is not essential in the diagnosis.

(5) There was apparently very little change in the blood chlorides in those patients who died in comparison to those who recovered. Patients did not do better with the administration of hypertonic saline as compared to normal saline. The fluids supplied was the important factor.

(6) Enterostomies do not lower the mortality except in some cases of adynamic ileus. If enterostomies are done they should drain the bowel on the table by cutting the bowel rather than using a catheter.

(7) Where there is interference with the blood supply to the bowel it is best to empty the contents of the bowel while the patient is on the table.

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# ACUTE INTESTINAL OBSTRUCTION AT THE NEW YORK HOSPITAL

A REPORT OF TWO HUNDRED AND THIRTY-FIVE CASES \*

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THIS work is an analysis and report of all cases recorded in the New York Hospital under the diagnosis of acute intestinal obstruction between the years of 1913 and 1930. The material for this study was made possible through the courtesy of Dr Eugene H Pool, Director of the Second Surgical Division, and Dr Charles L Gibson, of the First Surgical Division, and their associates of the New York Hospital.

As Sir Frederick Treves<sup>1</sup> pointed out in his book on Intestinal Obstruction, the final outcome in these cases is not primarily dependent upon the actual stoppage to the flow of material along the intestinal tract, but rather upon the absorption of toxic products from the disordered intestine resulting in septic infection of the whole body. He states that "The subjects of acute intestinal obstruction die for the most part with the phenomena of septic poisoning, and if a certain stage has been passed, the mere relieving of the obstruction does not save life." This last quotation sets forth clearly the serious aspects of this grave surgical condition.

The cause of death, in cases of acute obstruction, has been frequently discussed by clinicians and other investigators, and they have advanced many theories to explain it. Cooper<sup>2</sup> reviewed some 170 articles on intestinal obstruction and in his summary points out that in high obstruction there is (1) a profound disturbance in the acid-base mechanism resulting in alkalosis and dehydration, and also a definite toxæmia, (2) that there is a toxin in the lumen of the obstructed gut, which reaches the blood-stream, the origin of this toxin not being clear, (3) that there seems to be some mysterious connection between the toxæmia of high obstruction, acute pancreatitis, bilateral supiarenalectomy and anaphylaxis.

Sweet<sup>3</sup> believes that the principal organs concerned with the production of this toxin are the pancreas and the small intestine, especially the intestinal mucosa.

Ellis<sup>4</sup> states that this toxin is undoubtedly elaborated in the cells of the greater part of the mucosa of the small intestine, but chiefly in those of the duodenum. He also stresses the similarity between acute pancreatitis and high obstruction.

It may be stated, then, that in addition to the mere mechanical stoppage of intestinal flow, there is formed a toxin, presumably coming from the

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\* Read May 1, 1931, before the Surgical Section of the New York Academy of Medicine.

## ACUTE INTESTINAL OBSTRUCTION

mucosa of the small intestine, which makes acute intestinal obstruction a most serious problem

As this is a report of all cases analyzed, under the diagnosis of acute intestinal obstruction, no attempt will be made to adhere to any rigid classification, but rather the groups of cases will be discussed according to the pathological anatomy found. According to their frequency, these cases are grouped as follows

### Obstruction by

(1) Bands, adhesions, <i>etc</i>	110 cases
(2) Intussusception	36 cases
(3) Volvulus	16 cases
(4) Carcinoma of colon	16 cases
(5) Hernia	10 cases
	(Ext 6
	(Int 4
(6) Meckel's diverticulum	7 cases
(7) Gall-stones	4 cases
(8) Miscellaneous group	36 cases
	<hr/>
	235 cases
(a) Unknown cause	12
(b) Mesenteric thrombus	5
(c) Torsion of mesentery	1
(d) Paralytic ileus	6
(e) Tumor outside gut	3
(f) Congenital membrane	1
(g) Acute diverticulitis	1
(h) Polyp	1
(i) Sarcoma of colon	1
(j) Superior mesenteric artery	1
(k) Foreign body	1
(l) Megalocolon	1
(m) Ulcerative colitis	1
(n) Impacted feces	1

No effort was made in this series of cases to include anything not primarily diagnosed as acute intestinal obstruction. The few cases of strangulated hernia appearing were primarily diagnosed as acute intestinal obstruction, and the same holds true for the few cases of paralytic ileus which appear in the series.

*Diagnosis*—The symptoms and signs of acute intestinal obstruction make a familiar picture. The triad of symptoms, pain, vomiting, and obstipation, is still pathognomonic of acute obstruction. In this series of cases, on careful analysis of the patient's "chief complaint," it was found that *pain* was the symptom most frequently mentioned. Two hundred cases in this series mentioned pain as their foremost symptom. Three varieties of pain were recorded: first, the acute epigastric pain accompanied by nausea and vomiting, which follows the sudden twisting or strangulation of the abdominal viscera; secondly, dull pain referred to the site of the lesion, and,

thirdly, the intermittent spasms of pain caused by the peristaltic action of the gut as it meets an obstruction

*Vomiting*—One hundred eighty-seven cases complained of vomiting. The usual history was that vomiting came on with the pain and continued through successive stages until the final stage of faecal vomiting was reached. Faecal vomiting usually means impending death and certainly should not be awaited to make sure of the diagnosis. In this series 60 cases were mentioned as definite faecal vomiting, 54 of these died, giving a mortality of 90 per cent.

*Obstipation*—In 152 cases this condition was found as one of the chief complaints. In nearly all cases attempts to obtain evacuation of the bowels by cathartic or enemata had been resorted to, without satisfactory result. Obtaining flatus by enema or colon irrigation in these obstructed cases is very often misleading. Gas may be obtained in rather large quantities from the large intestine, while the small intestine above it is completely obstructed. In New York Hospital we have come to disregard an irrigation or enema which reports "much flatus" unless it contains definite colored matter from the small gut.

It is readily seen then that in this series of cases, pain, vomiting, and obstipation deserve their legendary importance as the triad of symptoms so common to acute intestinal obstruction.

*Physical findings*—In these findings 172 cases were described as acutely ill. *Distention* was mentioned in 131 cases. *Tenderness* was found usually over the area of gut involved and gave a fairly accurate indication of the site of trouble, thus making the path of surgical approach more definite, it was mentioned in 147 cases. *Rigidity* was present in 60 cases, and *tympanites* in 7. A definite mass was felt in 51 cases, *free fluid* in the abdomen was diagnosed in 7 cases. *Visible peristalsis* frequently mentioned as a sign of acute obstruction was recorded in only nine cases. The reason for this is obvious, as visible peristalsis depends upon a chronic, incomplete obstruction with hypertrophy of the gut, while in most acute cases dilatation and not hypertrophy takes place. *Auscultation*, as pointed out by Deaver<sup>5</sup> and others, will give a very accurate idea of the condition of the bowels. He states that "Early in obstruction there is stormy hyperperistalsis occurring in waves, starting suddenly and ending abruptly, resembling ocean waves during a storm." Hypoperistalsis indicates that the gut is rapidly going on to complete obstruction and paralysis. The last stage, where no peristaltic waves are heard, but an occasional tinkling, indicates complete bowel paralysis.

The temperature in this series of cases averaged 100°, with an average high level of 103°, and an average low level of 97.6°. The pulse averaged 100 a minute, with an average high of 146 and average low of 74. The respirations averaged 25 per minute, with an average high of 38 and average low of 19.

*Laboratory findings*—The leucocyte counts were reported in 157 cases

## ACUTE INTESTINAL OBSTRUCTION

The average was 15,445 white blood cells, with 80 per cent polymorphonuclears. The highest total count was 26,240 with 91 per cent polymorphonuclears, while the lowest count recorded was 5,940 with 62 per cent polymorphonuclears.

The urine was reported in 136 cases before operation. In 129 cases the urine was acid, 7 cases of alkaline, 99 cases showed albumen, 7 cases sugar, 32 showed casts, 24 acetone and 11 diacetic acid.

The blood pressure was recorded in only 23 cases before operation, the systolic pressure averaging 100, the diastolic 88.

Blood chemistry, in the small number of cases recorded, showed an increase in the blood sugar and urea nitrogen.

*Röntgen-ray examination*—Barium or other opaque meals should never be given in cases suspected of even partial obstruction for two obvious reasons. First, barium, in the majority of incomplete obstruction cases, will make the obstruction complete, and, secondly, in the event of subsequent operation and manipulation of the intestines, it will be regurgitated and aspirated, which will cause immediate death from suffocation. On the other hand, a plain plate of the abdomen in acute obstruction may be very helpful in the early stages. By this is meant the "step-ladder" appearance which the small intestine, when distended with gas, gives in the plain plate. Wangenstein and Lynch<sup>6</sup> in experimental work on dogs, found that enough gas collected in the small intestine in four to five hours after occlusion to give a definite X-ray shadow and make possible the early diagnosis of a block in the intestine. In twenty to twenty-four hours distention was fairly general even though the clinical distention was absent. Rabwin and Carter<sup>7</sup> in an article on the clinical aspects of plain X-ray diagnosis reported, at first, the "herring-bone" appearance of the small intestine and as the distention progressed further, the step-ladder type of picture developed. (See Fig 1.) They believed that because of the free use of plain X-ray examination in their cases of intestinal obstruction, they were coming to operation earlier and their mortality was definitely lowered. Later, the plain plate shows different gas-fluid levels which is quite diagnostic. (See Figs 2 and 3.) These phenomena appear relatively late in the acute obstruction, that is, after the bowels are badly paralyzed and distended, and are therefore not as important as the typical gaseous distention described above. Nineteen cases are recorded in this series as positive for gaseous distention of the small intestine and all were proven by operation to be obstructed. It is now the policy at the New York Hospital to take plain plates of every case suspected of acute obstruction.

No pre-operative diagnosis of obstruction was recorded in 58 cases which later proved to be acutely obstructed. An incorrect diagnosis was made in 33 cases. In this latter group the diagnosis of acute appendicitis was made 19 times, perforated peptic ulcer 3 times. The other 12 cases were distributed as follows: ectopic gestation 1, renal colic 1, twisted ovarian cyst 1, acute pelvic inflammatory disease 2, polyposis colon 1, hernia 2, pancreatitis



FIG 3



FIG 2



FIG 1

FIG 1—Plain X-ray plate of abdomen showing early distention of the gut by gas  
 FIGS 2 and 3—Plain X-ray plates of abdomen showing different gas fluid levels in an obstructed case

# ACUTE INTESTINAL OBSTRUCTION

I, carcinoma of colon I, diverticulitis of colon I, and acute gall-bladder disease I It would appear, then, that acute intestinal obstruction can be confused with practically any abdominal surgical condition

CHART I

MORTALITY BY HOURS AND BY CAUSAL FACT

HOURS	1-12		12-24		24-48		48-72		72-96		96-120		121-144		145-168		169-192		193-216		217-240		241-264		265-288		289-312		313-336		337-360		361-384		385-408		409-432		433-456		457-480		481-504		505-528		529-552		553-576		577-600		601-624		625-648		649-672		673-696		697-720		721-744		745-768		769-792		793-816		817-840		841-864		865-888		889-912		913-936		937-960		961-984		985-1008		1009-1032		1033-1056		1057-1080		1081-1104		1105-1128		1129-1152		1153-1176		1177-1200		1201-1224		1225-1248		1249-1272		1273-1296		1297-1320		1321-1344		1345-1368		1369-1392		1393-1416		1417-1440		1441-1464		1465-1488		1489-1512		1513-1536		1537-1560		1561-1584		1585-1608		1609-1632		1633-1656		1657-1680		1681-1704		1705-1728		1729-1752		1753-1776		1777-1800		1801-1824		1825-1848		1849-1872		1873-1896		1897-1920		1921-1944		1945-1968		1969-1992		1993-2016		2017-2040		2041-2064		2065-2088		2089-2112		2113-2136		2137-2160		2161-2184		2185-2208		2209-2232		2233-2256		2257-2280		2281-2304		2305-2328		2329-2352		2353-2376		2377-2400		2401-2424		2425-2448		2449-2472		2473-2496		2497-2520		2521-2544		2545-2568		2569-2592		2593-2616		2617-2640		2641-2664		2665-2688		2689-2712		2713-2736		2737-2760		2761-2784		2785-2808		2809-2832		2833-2856		2857-2880		2881-2904		2905-2928		2929-2952		2953-2976		2977-3000		3001-3024		3025-3048		3049-3072		3073-3096		3097-3120		3121-3144		3145-3168		3169-3192		3193-3216		3217-3240		3241-3264		3265-3288		3289-3312		3313-3336		3337-3360		3361-3384		3385-3408		3409-3432		3433-3456		3457-3480		3481-3504		3505-3528		3529-3552		3553-3576		3577-3600		3601-3624		3625-3648		3649-3672		3673-3696		3697-3720		3721-3744		3745-3768		3769-3792		3793-3816		3817-3840		3841-3864		3865-3888		3889-3912		3913-3936		3937-3960		3961-3984		3985-4008		4009-4032		4033-4056		4057-4080		4081-4104		4105-4128		4129-4152		4153-4176		4177-4200		4201-4224		4225-4248		4249-4272		4273-4296		4297-4320		4321-4344		4345-4368		4369-4392		4393-4416		4417-4440		4441-4464		4465-4488		4489-4512		4513-4536		4537-4560		4561-4584		4585-4608		4609-4632		4633-4656		4657-4680		4681-4704		4705-4728		4729-4752		4753-4776		4777-4800		4801-4824		4825-4848		4849-4872		4873-4896		4897-4920		4921-4944		4945-4968		4969-4992		4993-5016		5017-5040		5041-5064		5065-5088		5089-5112		5113-5136		5137-5160		5161-5184		5185-5208		5209-5232		5233-5256		5257-5280		5281-5304		5305-5328		5329-5352		5353-5376		5377-5400		5401-5424		5425-5448		5449-5472		5473-5496		5497-5520		5521-5544		5545-5568		5569-5592		5593-5616		5617-5640		5641-5664		5665-5688		5689-5712		5713-5736		5737-5760		5761-5784		5785-5808		5809-5832		5833-5856		5857-5880		5881-5904		5905-5928		5929-5952		5953-5976		5977-6000		6001-6024		6025-6048		6049-6072		6073-6096		6097-6120		6121-6144		6145-6168		6169-6192		6193-6216		6217-6240		6241-6264		6265-6288		6289-6312		6313-6336		6337-6360		6361-6384		6385-6408		6409-6432		6433-6456		6457-6480		6481-6504		6505-6528		6529-6552		6553-6576		6577-6600		6601-6624		6625-6648		6649-6672		6673-6696		6697-6720		6721-6744		6745-6768		6769-6792		6793-6816		6817-6840		6841-6864		6865-6888		6889-6912		6913-6936		6937-6960		6961-6984		6985-7008		7009-7032		7033-7056		7057-7080		7081-7104		7105-7128		7129-7152		7153-7176		7177-7200		7201-7224		7225-7248		7249-7272		7273-7296		7297-7320		7321-7344		7345-7368		7369-7392		7393-7416		7417-7440		7441-7464		7465-7488		7489-7512		7513-7536		7537-7560		7561-7584		7585-7608		7609-7632		7633-7656		7657-7680		7681-7704		7705-7728		7729-7752		7753-7776		7777-7800		7801-7824		7825-7848		7849-7872		7873-7896		7897-7920		7921-7944		7945-7968		7969-7992		7993-8016		8017-8040		8041-8064		8065-8088		8089-8112		8113-8136		8137-8160		8161-8184		8185-8208		8209-8232		8233-8256		8257-8280		8281-8304		8305-8328		8329-8352		8353-8376		8377-8400		8401-8424		8425-8448		8449-8472		8473-8496		8497-8520		8521-8544		8545-8568		8569-8592		8593-8616		8617-8640		8641-8664		8665-8688		8689-8712		8713-8736		8737-8760		8761-8784		8785-8808		8809-8832		8833-8856		8857-8880		8881-8904		8905-8928		8929-8952		8953-8976		8977-9000		9001-9024		9025-9048		9049-9072		9073-9096		9097-9120		9121-9144		9145-9168		9169-9192		9193-9216		9217-9240		9241-9264		9265-9288		9289-9312		9313-9336		9337-9360		9361-9384		9385-9408		9409-9432		9433-9456		9457-9480		9481-9504		9505-9528		9529-9552		9553-9576		9577-9600		9601-9624		9625-9648		9649-9672		9673-9696		9697-9720		9721-9744		9745-9768		9769-9792		9793-9816		9817-9840		9841-9864		9865-9888		9889-9912		9913-9936		9937-9960		9961-9984		9985-10000	
	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No of 'Cases'	Died 'Cases'	No																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													

successful operation for relief of the obstruction, or a hopelessly toxic patient who will die in spite of any surgical procedures instituted (See Chart I) It should be emphasized that 50 per cent of the present mortality rate can be attributed to the delay from the prolonged treatment by enemas, stipes and cathartics, by the doctor who first sees the case

*Bands, adhesions, etc*, comprised by far the largest group in this series There were 110 cases with 50 deaths, a mortality percentage of 45.45 per cent There were 105 operations with 44 deaths, a mortality of 41.8 per cent

This is comparatively the same as in Gibson's<sup>8</sup> series, where there were 186 cases and a mortality of 41 per cent, and Muzeneik<sup>9</sup> 104 cases with 48 per cent, also Miller<sup>10</sup> 58.8 per cent in 68 cases The treatment in this group varied The lowest mortality was obtained in those cases in which it was found necessary only to relieve the obstruction The more serious surgical procedures which involved opening of the gut, such as enterostomy and colostomy, were attended by an increasing death-rate (See Chart II)

The large number of cases in this group, 110, comprises 46.8 per cent of the whole number reported A striking fact in this group of cases was the frequency of previous abdominal operations which had occurred, and which antedated the obstruction from several days to twenty years Of the 235 cases in this report, 105, or 44.68 per cent, gave a history of previous operation about the abdomen Of these 105 cases 89 occurred in the band and adhesion group Carrying the analysis further, it is found that 52 of the previous operations had been appendectomies for acute or chronic appendicitis, and 27 for some pelvic condition Other previous operative procedures were in order of frequency as follows gall-bladder, stomach, pancreas, previous obstruction, carcinoma of colon, adhesions, upper abdominal, hernia, ruptured gut, diverticulitis, lipoma of sigmoid and empyema

The preponderance of obstruction cases following appendectomy and pelvic operations can be readily explained by the numerous adhesions found following operations for these conditions, especially for pelvic inflammatory disease, chronic appendicitis and drained acute appendicitis Here is truly a great opportunity for prophylaxis against subsequent obstruction by more careful handling of intestines, the careful application of disinfectants to the appendix stump, and also particular attention to careful reperitonealization of raw surfaces in the abdomen

*Intussusception*—There were 36 cases in this group, 21 males and 15 females Of these 5 were adults, 3 males and 2 females The remainder, 31 in all, were children There were 18 males and 13 females The average age of the children was 5.17 months The mortality in the intussusception group as a whole was 47.22, which also represents the operative mortality, as all cases were operated upon Most of the cases were simply reduced (see chart) while 4 resections gave 100 per cent mortality The mortality as given for intussusception by Gibson<sup>8</sup> was 51 per cent in 187 cases The time

factor is important in this group, as the best results were obtained in the cases operated upon early. Some of the earliest operations were done in this group, a very few hours following the onset of symptoms. The reason for this is obvious as the symptoms in children are typical and can scarcely be unrecognized. However, there are references, especially by older writers, showing that spontaneous cure may be brought about by sloughing off of the invaginated portion of the gut with subsequent passage of it by rectum. Haven<sup>11</sup> reported 59 intussusceptions out of a total of 258 cases of obstruction. Twelve of the 59 cases discharged the intussuscepted portion of the intestine by rectum, and of these 12 cases, 10 recovered.

*Volvulus of the colon*—Muzeneik<sup>9</sup> brings out some interesting data on this type of obstruction. In his statistical paper he shows that volvulus of the colon is much more common in the eastern European countries, especially Russia and the Balkans. There the incidence of volvulus in all cases of obstruction runs from 30 to 75 per cent. In Germany during the years 1918-1919 there was a tremendous and sudden increase in the number of cases as compared to former and later years. This, he thought, was due to post-war conditions. He attributes the increased frequency of volvulus of the colon in eastern Europe to the prevalence of dysentery, typhus and other diseases which cause a mesosigmoiditis with subsequent narrowing and contraction of the base of the mesentery. This gives a pedunculated offset to the sigmoid and makes possible torsion on its pedicle, especially if the loop of sigmoid becomes distended with gas and faeces. In the present series there were 16 cases with 7 deaths, a total mortality of 43.75 per cent. Thirteen cases were operated upon and 6 died for an operative mortality of 46.15 per cent as compared to 58.5 per cent of Miller,<sup>10</sup> Gibson<sup>8</sup> 54 per cent and Muzeneik<sup>9</sup> 36 per cent. For operative details see Chart II. Of the 13 operations there were 2 resections with no deaths, 6 colostomies (including cæcostomies and appendicostomies) with 4 deaths, in 5 cases, only the obstruction was relieved, with 2 deaths. Two cases were volvulus of the cæcum, one complete with 360° torsion, the other a partial volvulus with 180° torsion. All others were of the sigmoid colon.

*Meckel's diverticulum*—There was nothing of note in this class of cases. The group was small, 7 in number, with 4 deaths, a mortality of 57.14 per cent. All cases were operated upon. Gibson<sup>8</sup> reported 42 cases with 62 per cent.

*Gall-stones*—Showed only 4 cases. All were operated upon and 3 died, with 75 per cent mortality.

*Hernia*—There were 6 cases of external strangulated hernia with 2 deaths, or 33.33 per cent. There was nothing unusual in these cases. One death was preceded by a resection of the small gut and the other by a primary enterostomy.

*Internal hernia* showed 4 cases, one case was herniated through an aperture in the mesentery, two were in internal sacs, and one in the lesser perito-



neal sac One case died, a resection of the small intestine, 3 lived, with a mortality of 25 per cent

*Carcinoma of the colon*—There were 16 cases all of which had suddenly closed down and become acutely obstructed Sixteen cases were operated upon, with 5 resections and 3 deaths, 5 colostomies with 4 deaths, 4 enterostomies with 3 deaths, a total of 12 deaths, or 75 per cent

The miscellaneous group deserves a few comments There were 12 cases where the cause of obstruction was not ascertained at operation In most of these the patient was too ill to permit of a prolonged search Nine cases died, a mortality rate of 75 per cent *Mesenteric thrombosis* showed 5 cases with 4 deaths The only operative case that survived was one operated upon by Doctor Pool This case is reported elsewhere The other cases of the miscellaneous group are single ones and self-explanatory

*Treatment*—For the most part Chart II explains the result of treatment The ante-operative and post-operative treatment, and the operative treatment with especial reference to enterostomy will be discussed briefly

*Ante-operative treatment*—The more important ante-operative procedures in acute intestinal obstruction may be stated as follows (1) Rapid restoration of body fluids, (2) gastric lavage, and (3) enemata Fluids may be restored most rapidly by means of hypodermoclysis and infusions of normal saline This is probably the greatest single factor in combating the patient's shock and toxæmia, and it is a good rule to make, that these cases should not be operated upon until they have had at least 1000 cubic centimetres of saline by vein or subcutaneously

Lavage is important to relieve the dilated stomach of toxic material from the intestine and also to prevent possible aspiration during anaesthesia

Enemata which return gas and small particles of faecal matter may cause unnecessary delay in cases that are really obstructed On the other hand a totally negative result from an enema is a consoling fact in assisting to make the proper diagnosis

*Operative treatment*—In general, the simplest procedure possible, in the presence of the pathological changes found, will obtain the greatest number of living patients The necessity of more serious surgical measures and their results are best illustrated in Chart II

The rôle of enterostomy in these cases has been much discussed Van Beuren<sup>12</sup> believes that there is statistical evidence to indicate that enterostomy in acute ileus is of value if done early However, late enterostomies, after paralysis of the intestine has taken place, drain only that loop into which the drainage tube is inserted In this series there were 44 enterostomies done with 33 deaths, or 75 per cent mortality as against 43.67 per cent mortality for all other methods This may be an unfair comparison because, in some cases, the patient was considered too ill to explore On the other hand, it would seem to be bad practice to do only an enterostomy without exploration, as in 2 cases of the series where this was done the obstruction was found at autopsy to be due to a single band which could easily have

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been released Supportive measures should be given as indicated during operation

*Anæsthesia*—General anæsthesia was used in 185 cases, with 86 deaths Local anæsthesia was used in 29 cases with 21 deaths Spinal was used only once with 1 death In one case no anæsthesia was used

*Post-operative treatment*—The restoration of body fluids by saline clyses and infusions should be vigorously pursued The patient's tongue is an excellent indicator, if it is dry and "beefy" in appearance, the patient still needs fluids Fluids by mouth may be given after vomiting has ceased Hypodermoclysis and other treatment should be concentrated at regular intervals, as every four hours, so that between treatment time the patient may rest Lavage at regular intervals of every four hours should be rigidly carried out until the necessity for it is over Position in bed is felt to be very important The flat position in bed tends to distribute the intestines and their contents more evenly and prevents sagging of individual distended loops and the distended stomach toward the pelvis This was pointed out by Gibson and Wade<sup>13</sup> Washing out of the lower bowel at regular intervals will stimulate peristalsis and relieve the body of toxic material The administration of charcoal gr XV by mouth and its subsequent excretion by rectum gives positive proof that the obstruction to the gut has been overcome Other less important measures practiced post-operatively in this series are too numerous to mention

### SUMMARY

The conclusions from this study of acute intestinal obstruction are therefore given, with full knowledge of the pitfalls encountered in any statistical survey The fact that all these cases are reported from one hospital and have been treated by the same group of individuals over a long period of time might increase the value of these conclusions They are as follows

(1) In this series there were 235 cases reported under the diagnosis of Acute Intestinal Obstruction, (2) the mortality was 51.48 per cent, (3) the average age was thirty-two years, (4) there were 118 males and 117 females, (5) The average duration of symptoms before treatment was 3.9 days, (6) plain X-ray films are helpful in early diagnosis of acute obstruction to the intestines, (7) there were 218 operations, 17 not operated, and 49 secondary operations, with an operative mortality of 58.4 per cent, (8) previous abdominal operations are a definite etiological factor for later obstruction, especially in the band group of cases, (9) the duration of obstruction before surgical correction is a very important factor in the prognosis, (10) the more severe surgical procedures, such as resections gave a higher mortality than the cases where it was only necessary to release the obstruction by cutting a band, (11) primary enterostomy gives a higher mortality rate than a combination of all the other surgical procedures, (12) these statistics agree closely with statistics compiled thirty years ago and also with those of today

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# ACUTE INTESTINAL OBSTRUCTION

A REPORT OF ONE HUNDRED AND EIGHTY-FIVE CASES TREATED IN THE  
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THE mortality rates of acute intestinal obstruction vary with respective series. Miller<sup>1</sup> reported a mortality of 29.4 per cent of cases operated upon within twelve hours after the onset and 52.9 per cent within twenty-four to forty-eight hours, and as the time increased the mortality increased, hence, after ninety-six hours, the rate was 84 per cent. Gibson's series of 1,000 cases had a mortality of 43.2 per cent and 41.08 per cent for the Van Beuren and Smith series of 1,089 cases. It is generally agreed that the rate averages about 40 to 50 per cent—about one of every two patients die.

Since 1922, 185 cases of acute intestinal obstruction were admitted to the surgical services of Lebanon hospital, ten of which were non-operative cases. Of the total admissions 112 were males and seventy-three females, and of these, forty-two males and twenty-nine females died, making a total of 38.38 per cent. Excluding the group of intussusceptions the largest number of admissions were between the ages of fifty-one to sixty, with a total of thirty-six cases followed by twenty-seven in the seventh decade. The others occurred from one day to eighty-four years of age. From the third decade the foremost causative factor of acute intestinal obstruction was hernia. Sixty-six cases of this series were classified under the general heading of hernias, twenty-eight of which were due to indirect inguinal and twenty-one to femoral hernias. Four were umbilical, five ventral, three median and five congenital. Three cases were due to reduction "en masse"<sup>2</sup>. Post-operative adhesions are second of importance with a total of twenty-six cases. Sixteen of these cases produced symptoms one month to twenty-five years after the primary operation and of these twelve were following appendectomies, four of which were diam cases. Ten cases were more acute in that the symptoms of acute intestinal obstruction appeared from three to six days after the primary operation for acute appendicitis. At the secondary operation the presence of fine adhesions between loops of bowel or connective tissue (bands) were found.

Obstruction as result of new growths was present in ten cases. Six of this group were due to adeno-carcinoma of the sigmoid and two of these had a secondary abscess (of the sigmoid) as result of perforation of the bowel. One new growth was found in the rectum, descending colon and hepatic flexure respectively. It is of interest to state that none of these cases presented objective or subjective symptoms prior to the onset of symptoms of acute intestinal obstruction. There were seven cases of post-operative ileus.

and nine patients who had a volvulus. One of these patients presented a volvulus of the ileum due to a band adherent to the left superior surface of the uterus. The others all had a volvulus of the sigmoid and one of these presented a tumor mass (adeno-carcinoma) of the sigmoid as well. Foreign bodies causing intestinal obstruction were present in three cases. In one, a female sixty-two years of age, a plum pit had produced a pin-point perforation of the ileum and localized abscess. The other two were due to a gallstone in the ileum and a polyp. The polyp was present in a young male who was operated for a ruptured appendix. On the sixth day post-operative he began to present the clinical picture of intestinal obstruction, and on the eleventh day he passed a large slough through the anus, which was described by the pathologist as a polyp. Subsequent X-ray examination revealed the presence of papilloma of the cæcal region. Ten cases were admitted with subjective symptoms of intestinal obstruction and a history of a previous operation. One of these had been operated upon previously for acute intestinal obstruction. All were kept under observation and after a reasonable period were discharged without any surgical interference. These cases are a group that have spontaneous relief or as result of enemata. In the first decade there is no group of cases that exceeded intussusception in the causation of acute intestinal obstruction. There were thirty-four cases, the majority of which were of the ileocæcal variety.<sup>3</sup>

During the above period cases of intestinal obstruction were admitted to the surgical services and operated upon for this condition without apparent cause, as adhesions, malignancy, *etc*. Ten of such cases were admitted and in three of the cases the cause was found—two had bands and one passed a polyp per rectum several days post-operative. The autopsies of four cases revealed the causes as (a) old tuberculosis band—with no other process in the body, (b) stone in the ileum, (c) benign stricture of the rectum, and (d) ileus secondary to a ruptured perinephritic abscess into the peritoneal cavity, which, in turn, was secondary to a stone in the ureter.

Disease of the vascular system in the region of the intestinal tract has not received its due recognition in the past. The fact that there are changes in the mesenteric vessels as there are throughout other parts of the body in arteriosclerotic conditions is becoming more generally recognized by the profession. Recently Green and Powers<sup>4</sup> have reported several cases of spontaneous hæmorrhage into the omentum due to a rupture of branches of the left gastric, gastroduodenal, left epiploic and superior mesenteric arteries. The operations revealed definite arteriosclerotic changes in the vessel walls. The arteries are primarily involved in patients past the fourth decade and the condition is that of a general arteriosclerosis. As a rule, the involvement of arteries supplying the intestines, prior to the latter period, are usually due to (a) embolism secondary to a cardiac condition, (b) septic emboli, and (c) local thrombosis as result of pressure on the vessels. Involvement of the venous system will present the same clinical picture. Thrombosis of the

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venous vessels can result in involvement (*a*) from the bowel or (*b*) from a primary focus in another part of the body

Two cases in this series illustrated the involvement of the venous vessels. Both were in young males sixteen and twenty years of age. One was admitted with a history of one day's duration with all the cardinal symptoms of intestinal obstruction and at operation twelve feet of ileum covered with a thin membrane and black in color with serosanguinous fluid were found. Post-mortem findings revealed about fifteen feet of small intestines up to the ileocaecal valve gangrenous. The mesenteric vessels leading to this portion of intestines were thrombosed and markedly dilated. Dense adhesions between the old scar, mesentery and ileocaecal region were present which caused the pressure on the mesenteric vessels and thrombosis. The second case was following an illness of two weeks' duration, subsequent to an upper respiratory infection which confined the patient in bed for ten days. The operative findings revealed the mesentery of the small bowel hard, infiltrated and covered with fibrin and fourteen feet of the bowel dark in color. Post-mortem examination found the gut to be gangrenous, the mesenteric glands were large, and one section contained purulent material. The veins were thrombosed, with small abscesses in the liver. These are illustrations of thrombosis of the venous vessels of the mesentery. The first is due to local involvement and second from a primary focus in another part of the body (upper respiratory tract).

TABLE I

Cases	No	Male	Female	Deaths		% of total admissions	% of total mortality
				M	F		
Hernias	66	44	22	10	7	37.5	23.94
Adhesions	26	15	11	5	4	14.77	12.67
Malignancy	10	7	3	2	2	5.4	5.6
Secondary ileus	7	4	3	4	3	3.97	9.85
Volvulus	9	4	5	2	2	5.1	5.3
Mesenteric thrombosis	7	3	4	3	4	3.78	9.85
Anomalies	3	2	1	1	1	1.62	2.81
Intussusception	34	23	11	7	4	18.27	15.48
Foreign bodies	3	1	2	1	1	1.62	2.81
Miscellaneous	10	7	3	6	1	5.38	9.8
Non-operative	10	2	8	0	0	5.4	0.0

In summation, one readily appreciates that hernias, adhesions, and intussusceptions are the greater factors numerically but not so far as the mortality rate is concerned. In mesenteric thrombosis, post-operative ileus, anomalies, malignancy and cases of unknown origin, the mortality either equals or surpasses the percentage of admissions of each respective group.

*Pathological Discussion*—Extensive investigation has developed various opinions about the toxicity in acute intestinal obstruction. As the result a number of theories have been formulated and classified as (1) bacterial, (2) intoxication, (3) dehydration—of body fluids and salts, (4) infections, (5) neurological, (6) secretory—excessive or perverted, and (7) circula-

tory Many of the above have supportive evidence experimentally, while others are still debatable However, with the reviews of operative and extensive pathological findings, and the knowledge of the sequence of events of this condition (pathological physiology) one is immediately impressed with the important changes taking place within the circulation of the intestinal tract The interference with the return flow, thrombosis, infarction, œdema, exudation of a serous or hæmorrhagic fluid, are a series of definite progressive pathological circulatory changes, which result finally in non-viable or gangrenous gut There can be no question that the prognosis should be guarded and depend upon the progressive changes and the success of any surgical or therapeutic measure is based, primarily, on the circulatory changes The duodenum, jejunum and colon vary as far as intramural blood supply is concerned and react to intra-intestinal pressure differently The pressure within the duodenum can interfere with the venous flow if it reaches thirty-five to forty-five millimetres of mercury or above, while the jejunum and ileum fifty-five to sixty-five and ninety-five for the colon, will be sufficient to produce interference to the venous flow <sup>5</sup>

The work of Raine and Perry<sup>6</sup> as well as the work of Hartwell and Hoguet<sup>7</sup>—though they state that the salt solution is the important factor, nevertheless, the success of their experiment depends upon the circulation being normal—with summary of the above (paragraph) is sufficient to demand the respect and consideration of the profession It can be emphatically stated that the toxicity of intestinal obstruction is due to the vascular disturbances and the subsequent changes thereof The other factors (especially the sodium chloride), as enumerated, are of importance, but only in a secondary measure, and the therapeutic measures based upon these experimental observations depend upon the circulation for their successful action

The effort to understand the mechanics and chemistry of acute ileus has stimulated extensive investigation and the theories (1), of stimulation of the splanchnics—resulting in dilatation—through the inhibitory action of the nerves as well as (2), the action of sodium chloride, are the foremost conclusions advanced The cases of ileus, with definite local and general peritonitis, are caused by the action of the toxins, causing a disturbed innervation of the intestinal wall and partly to the formation of masses of flakes of fibrin with the cohesion of coil to coil, thus interfering with the circulation <sup>8</sup> However, the cases where no visible infection or presence of pus can be seen are the ones that now present themselves for consideration These cases usually develop symptoms of intestinal obstruction from three to six days after the operation The questions now present themselves, (*a*) are cases of this type the result of neurological disturbances as suggested? (*b*) is it due to a disturbance of the sodium chloride in the body? (*c*) is it due to a combination of the above? or (*d*) is it due to some other factors? In order to answer the questions we will consider the following

(*a*) The action of smooth muscle is not totally dependent upon its extrinsic nerve supply, thus differing from the voluntary or striated muscle—"thus,

whereas the voluntary muscle is intimately dependent on its connections with the central nervous system, and in the absence of this is reduced to a flabby inert tissue, the smooth muscle, isolated from its nervous connections, presents in many cases rhythmic contractions and can carry out a peripheral adaption to its environment. These rhythmic contractions are almost invariably observed if the muscular tissue be subjected to a certain amount of tension after separation from the central nervous system."<sup>9</sup>

(b) The phenomenon of fatigue depends upon two factors—(a) consumption of contractile material or substances available for the supply of potential energy. (b) A more important factor is the accumulation of waste products of contraction. Among these products lactic acid is probably of great importance.<sup>10</sup>

(c) "Intestinal muscle acts independent of the spinal nerve supply. The rhythmical contractions of the intestines are muscular in origin (myogenic) while the more coordinated peristaltic movements depend upon the intrinsic nervous mechanism (Auerbach Plexus). The intestines, however, are not dependent for either movement upon their connections with the central nervous system. Like the stomach, it is an automatic organ whose activity is simply regulated through its extrinsic nerves."<sup>11</sup>

(d) Disturbances of the autonomic system present clinical entities but none of serious concern nor symptoms pointing to any intestinal obstruction. These entities are vagotonia and sympathotonia.<sup>12</sup>

(e) When nerves to the digestive tract are cut little happens. There is a short interval during which the muscle may be somewhat atonic and during which peristalsis is shallow, but later, in many experimental animals, little difference from the normal can be made out.<sup>13</sup>

(f) The cutting of the sympathetics in man has seldom resulted in any disturbance.<sup>14</sup>

The neurological theory has been advanced by the work of many investigators, especially the experimental work of Cannon and Murphy,<sup>15</sup> who showed that a dynamic ileus experimentally produced by crushing the testicle could be presented by cutting the splanchnics. The recent work of spinal anaesthesia with clinical observations has been suggested as supportive evidence of this theory.

Physiologically, the stimulation of the splanchnics in experimental animals gives rise to a dilatation of the intestines. The reverse is true with the vagus autonomic system. These reactions are purely of a tonic nature. The question arises, can excessive stimulation of the above produce acute ileus with the typical picture of acute intestinal obstruction and death? This has not been demonstrated, for if one stimulates the nerve to a striated muscle one gets a definite twitch which can be produced time and again in practically the same form, but if one stimulates the vagi or sympathetics one gets varying changes of weak inhibition and stimulation which cannot be duplicated with any degree of certainty or precision.<sup>16</sup> It has also been demonstrated that one can get purely inhibitory effects by stimulating the vagus, just as one



can get purely augmentary effects by stimulating the splanchnics<sup>17</sup> Hence, it is obvious that the reaction to stimulation of the splanchnics is not constant nor definite However, some have advanced the clinical entities of vagotonia and sympathotonia as manifestations of disturbance of the respective autonomic systems, but none has ever reported a case under the latter condition, with a clinical picture of acute intestinal obstruction and death In fact, the possibility of a spontaneous case of acute ileus without any injury or subsequent to a recent operation is remote, speculative, and never reported

The injury to the testicle (Cannon and Murphy Exp) produces a stimulus which is transferred to the higher centres through the splanchnics The result is shock Crile believes the reason for shock is due to exhaustion of the vasomotor centre with splanchnic vascularization However, primary shock, which appears to be the immediate reflex effect of a sudden injury due to inhibition of the heart through the vagus, results in dilatation of the splanchnic area With this comes an increased permeability of the arteriol walls so that fluid passes out into the tissues This gives rise to œdema and interference with the nutrition to the intestines through impaired circulation (stasis) resulting in ileus<sup>18</sup> By cutting the splanchnic fibres the stimulus is not transferred to the higher centres and therefore no response as described The interpretation of this experiment differs from the authors in that they described the result due to stimulation of the splanchnic nerves whose action is supposed to be directly upon the intestinal muscle, while the deduction above is that the stimulus is transmitted through the splanchnics to the higher centres In fact, clinically, the same mechanism is present in patients who have had severe injuries in other parts of the body, other than the abdomen as upper extremities, chest, head, *etc* Many of these cases of injury to the testicle and abdomen recover without any permanent condition of acute dilatation A frequent example is the prize fighter who is struck in the abdomen and recovers after a short time The reason for this is due to the stability of the vasomotor mechanism reestablishing the circulation by control of the arteriols in the splanchnic area

The use of spinal anæsthesia in the treatment of acute ileus has been reported by some as satisfactory, but others were unable to report favorable results The reason for this is explained as follows (a) at operation, where spinal anæsthesia has been used, there is a collapsed bowel This is the result of paralysis of the splanchnics with loss of vasomotor control as well as the tonic influence of the sympathetics The result is identical with shock, and, in fact, the result of the spinal anæsthesia is the formation of clinical shock One readily appreciates the patient's appearance, his color, clammy perspiration, difficulty in breathing, rapid, weak pulse, and the extremely low blood-pressure (a decrease from 50 to 100 millimetres of mercury) This is one of the reasons for keeping the patient in a Trendelenburg position to overcome the vascular anæmia to the higher centres as a result of the vasomotor instability, resulting in splanchnic vascularization (b) In cases of ileus the condition has been present for a number of days, during which time

there is interference with the circulation (nutrition) and increased distention. The lactic acid present paralyzes the neuromuscular plate, thus severing its control, which is purely a tonic factor. The excessive intra-intestinal pressure (distention) impairs the venous flow, and indirectly the arteriols, resulting in dilatation, due to back pressure from the venous obstruction. Therefore, the rapid vasodilatation, after the use of the spinal anaesthesia, does not develop. For the arteriols are dilated and the sudden change in the splanchnic area, as described in conditions of shock, does not take place. The distention also continues—for this pressure has distended the muscular wall, producing exhaustion and loss of muscular elasticity. Therefore, under the latter conditions, the use of spinal anaesthesia is of no value, and its influence can be of importance only as a therapeutic measure when the condition of ileus is treated early. Here the mechanisms are still under the normal influences.

Acute ileus results from the action of toxic substances as in pneumonia, uræmia and drug conditions. The action here is directly upon the muscular layers of the bowel, producing a toxic paresis.<sup>19</sup> In surgical conditions the appearance of acute ileus takes place from the third to sixth day after the primary operation, with the insidious onset of nausea, vomiting, retching, distention and cramps. The pulse, respiratory rates as well as the temperature are increased. The blood shows a leucocytosis. The onset from the third day suggests the possibility of some form of inflammation as in post-partum conditions—sepsis.

The agents that can produce inflammatory reactions other than bacterial invasion are chemical, traumatic, physical and thermal agents. The presence of a dynamic ileus after the primary operation (excluding the inflammatory group) within a limited period suggests the possibility of the onset having taken place at the first operation and after a period of development the entity appears. The prolonged exposure of gut, excessive handling of the bowel, pressure on the intestines through abdominal pads and instruments (retractors) are agents competent to produce injury to the bowel. It is this injury (maltreatment) that is responsible for the development of subsequent ileus, for it has been definitely demonstrated that obstruction, without injury to the intestines, will not produce ileus. However, ileus can be produced by injury to the intestines (maltreatment) without any obstruction anywhere in the bowel.<sup>20</sup> In fact, it has been shown that injury to the intestinal muscles will give the same symptoms as the reflex upsets that result through the splanchnic.<sup>21</sup>

The appearance of the bowel, pathologically, reveals two distinct types (*a*) thin, injected, covered with fibrin or flakes of pus, which are found in cases of post-operative peritonitis, and the (*b*) pale, white, anæmic, distended under excessive pressure. The color of the second type (pale-anæmic) is most likely due to the excessive intra-intestinal pressure forcing the blood out of the vessels, thus giving this characteristic appearance.

In summarizing it can be stated that (*a*) the physiological characteristic

features of the smooth muscle (intestinal) isolated from its nervous connections can carry out a peripheral adaptation to its environment, which is readily brought about through paralysis of the neuromuscular plate by retention of lactic acid (b) The ability to maintain its function independent of the nervous system (myogenic theory) is a definite physiological fact as well as (c) the clinical knowledge that cutting of the sympathetics has no effect upon the digestive function in man (d) The development of ileus after a constant period pointing to the origin at the primary operation with the enumerated agents giving rise to a non-suppurative inflammatory reaction, and the (e) inability of spinal anæsthesia to influence the condition on all occasions are supportive factors in stating conclusively that the cause of acute ileus after a primary operation (excluding the peritonitis cases) is due primarily to an injury to the intestines at the operation which gives rise to a non-suppurative inflammation The effect of the splanchnic system upon this condition is not of serious significance

The work of the sodium chloride advocates has been conclusive and of importance, but as Hartwell and Hoguet have stated, the success of their experiment depends upon the circulation being maintained as normal, while they supply the salts and fluid to the body It is also a fact that the first of the series of events is not vomiting with depletion of body fluid and salts but the interference with the circulation

*Diagnosis and treatment*—These phases have been described and discussed The literature and reports are explicit and cover this phase to a large degree However, a number of suggestions have been advanced to assist in the diagnosis but none other than two are of great importance (a) Radiographic examination, (b) gastric lavage Radiographical investigation by the use of barium enemas has conclusively proven its worth and the work of Schwarz advocating the use of the roentgenography of the abdomen has proven to be of material assistance The importance of visualization of gas in the small intestines on radiographical examination in adults has not received its due consideration For the presence of the latter is synonymous with intestinal obstruction<sup>22</sup>

One of the most useful diagnostic aids that can be used with simplicity and ease, especially where there are no first-hand facilities as X-ray, *etc*, is gastric lavage The washing of the stomach until the return flow is clear, and repeated within an hour, is of great significance, especially if the return fluid of the last washing contains high intestinal or fecal-like material The presence of the latter is synonymous and pathognomonic of intestinal obstruction

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# ACUTE INTUSSUSCEPTION

WITH SPECIAL REFERENCE TO TREATMENT BY RESECTION OF THE BOWEL \*

OBSERVATIONS ON THIRTY-FOUR CASES ADMITTED TO THE  
CHILDREN'S HOSPITAL IN PHILADELPHIA

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THE purpose of this paper is First, to review the cases of intussusception admitted to the Children's Hospital of Philadelphia in the last seven years, and to compare this series with the series of the ten previous years reported by Brown, second, to report a successful application of Brown's method of reduction, by incision, of the constricting ring of the intussusception, and, third, to report a successful resection of the distal end of the ileum the cæcum, the ascending, transverse and descending colon to the sigmoid, all of which were involved in the intussusception

TABLE I

*Doctor Brown's Series*

Duration of intussusception	No of cases	Reduced Lived	Reduced Died	Not reduced Lived	Not reduced Died	Per cent mortality according to duration of intussusception
24 hours or less	9	6	3	0	0	33 3
48 hours	9	2	5	1	1	66 6
72 hours	6	1	3	0	2	83 3
4 days	2	0	2	0	0	100 0
5 days	3	0	0	0	3	100 0
6 days	1	0	0	0	1	100 0
Over 6 days	1	1	0	0	0	0 0
Total for series	31	10	13	1	7	64 5 per cent mortality

In 1924, Doctor Brown read a paper before this Academy in which he reported thirty-one cases (Table I) admitted to the Children's Hospital of Philadelphia with intussusception, between 1915 and 1924<sup>1</sup> We wish to report an additional thirty-four cases (Table II) which have been admitted to the Children's Hospital since that time, making a total of sixty-five cases (Table III) On the accompanying charts are tabulated the results, but there are a few points to which we wish to call attention

The percentage of mortality has been reduced from 64 5 per cent, in Brown's report to 35 3 per cent in this later series, the best results as would

\* Read before the Philadelphia Academy of Surgery, January 4, 1932

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TABLE II

Duration of intussusception	No of cases	Reduced Lived	Reduced Died	Not reduced Lived	Not reduced Died	Per cent mortality according to duration of intussusception
24 hours or less	13	9	4	0	0	30.8
48 hours	10	8	1	1	0	10.0
72 hours	3	1	0	0	2	66.7
4 days	2	1	1	0	0	50.0
5 days	3	0	3	0	0	100.0
7 days	1	1	0	0	0	0.0
Over 7 days	1	0	0	1	0	0.0
Duration unknown	1	0	1	0	0	100.0
Total for series	34	20	10	2	2	35.3 per cent mortality

be expected, being in the cases operated on early. Thirteen patients were operated on in the first twenty-four hours, with four deaths, or 30.8 per cent mortality, ten were operated on in the first forty-eight hours, with one death,

TABLE III  
(Combined I and II)

Duration of intussusception	No of cases	Reduced Lived	Reduced Died	Not reduced Lived	Not reduced Died	Per cent mortality according to duration of intussusception
24 hours or less	22	15	7	0	0	31.8
48 hours	19	10	6	2	1	36.8
72 hours	9	2	3	0	4	77.7
4 days	4	1	3	0	0	75.0
5 days	6	0	3	0	3	100.0
6 days	1	0	0	0	1	100.0
7 days	2	2	0	0	0	0.0
Over 7 days	1	0	0	1	0	0.0
Duration unknown	1	0	1	0	0	100.0
Total both series	65	30	23	3	9	49.2 per cent mortality

or 10 per cent mortality. After this time the mortality rapidly increased. In several of the cases appendectomy was done, but we do not recommend this procedure unless the appendix is gangrenous.

TABLE IV

CASE I—(Hospital Case No 501), F. L., male, four years old, palpable mass. Feeding—? Condition on admission—fair. Type—colic. Operation to reduce. Result—died. Remarks—Reduced with difficulty. Colon stitched to abdominal wall. Recurred. This case reported.

CASE II — (Hospital Case No 227), F B B, female, six years old, palpable mass Feeding—? Condition on admission—fair Type ileo-cæcal Duration—thirty hours Operation to reduce Result—died Remarks —Acute appendicitis Ileum explored for questionable tumor and sutured Wound reopened for infection

CASE III — (Hospital Case No 263), T E, female, four and one-half years old, palpable mass Feeding—? Condition on admission—good Type—ileo-cæcal Duration—one week Operation to reduce Result—recovered Remarks —Appendix removed

CASE IV — (Hospital Case No 1062), R C, female, eight months old, palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—seventeen hours Operation to reduce Result—recovered

CASE V — (Hospital Case No 1088), M T, female, ten and one-half months old, palpable mass Feeding—breast Condition on admission—fair Type ileo-cæcal Duration—thirty-six hours Operation to reduce Result—recovered

CASE VI — (Hospital Case No 122), V M, female, ten months old, non-palpable mass Feeding—breast Condition on admission—fair Type—ileo-cæcal Duration—forty hours Operation to reduce Result—recovered Remarks —Appendectomy

CASE VII — (Hospital Case No 391), A M A, female, two months old, non-palpable mass Feeding—breast and bottle Condition on admission—poor Type—ileo-cæcal Duration—three days Irreducible operation Result—died Remarks —Resected part of mass Cæcostomy Died on table

CASE VIII — (Hospital Case No 355), V T, female, three months old, palpable mass Feeding—breast Condition on admission—poor Type—ileo-cæcal and colic Duration—five days Operation to reduce Result—died Remarks —Peritonitis Reduced with difficulty

CASE IX — (Hospital Case No 370), D L G, female, four months old, non-palpable mass Feeding—breast Condition on admission—fair Type—ileo-cæcal Duration—fourteen hours Operation to reduce Result—died Remarks —Appendectomy Bronchial pneumonia

CASE X — (Hospital Case No 608), F C, male, five months old, palpable mass Feeding—breast Condition on admission—poor Type—ileo-cæcal Duration—twenty-four hours Operation to reduce Result—died Remarks —Bowel torn in two places Sutured

CASE XI — (Hospital Case No 652), C G, male, four and one-half years old, non-palpable mass Feeding—? Condition on admission—fair Type—ileo-cæcal Duration—eleven days Irreducible operation Result—recovered Remarks —two and one-half inches ileum resected Symptoms followed gulping spaghetti

CASE XII — (Hospital Case No 781), M P, male, seven months old, palpable mass Feeding—breast and bottle Condition on admission—fair Type—ileo-cæcal Duration—twenty-four hours Operation to reduce Result—died Remarks —Eviscerated fifteen days after operation

CASE XIII — (Hospital Case No 791), W H, male, seven weeks old, palpable mass Feeding—breast Condition on admission—poor Type—ileo-cæcal and colic Duration—thirty-six hours Irreducible operation Resected Result—recovered Remarks —Case reported

CASE XIV — (Hospital Case No 415), M L, male, eleven months old, palpable mass Feeding—? Condition on admission—fair Type—ileo-cæcal Duration—three days Operation to reduce Result—recovered Remarks —Stitched to abdomen

CASE XV — (Hospital Case No 630), J W, female, nine months old, palpable mass Feeding—breast Condition on admission—poor Type—ileo-cæcal Duration—five days Operation to reduce Result—died twenty-six hours after operation

CASE XVI — (Hospital Case No 691), M G, male, eight months old, palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—

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forty-one hours Operation to reduce Result—recovered Remarks—Time of operation twenty-one minutes

CASE XVII—(Hospital Case No 378), E M, male, three months old, palpable mass Feeding—? Condition on admission—good Type—ileo-cæcal Duration—twenty hours Operation to reduce Result—recovered Remarks—Appendectomy

CASE XVIII—(Hospital Case No 979), T B, male, eleven months old, palpable mass Feeding—breast Condition on admission—fair Type—ileo-cæcal Duration—thirty-six hours Operation to reduce Result—recovered Remarks—Appendectomy

CASE XIX—(Hospital Case No 264), D G, male, eight months old, palpable mass Feeding—breast Condition on admission—fair Type—ileo-cæcal Duration—twenty-four hours Operation to reduce Result—died Remarks—Cæcum sutured to abdominal wall

CASE XX—(Hospital Case No 126), R A, female, five and one-half months old, palpable mass Feeding—breast Condition on admission—good Type—colic Duration—twelve hours Operation to reduce Result—recovered Remarks—Ileum sutured to cæcum and abdominal wall

CASE XXI—(Hospital Case No 137), A P, male, six and one-half months old, palpable mass Feeding—? Condition on admission—good Type—ileo-cæcal Duration—two hours Operation to reduce Result—recovered Remarks—Local anæsthesia

CASE XXII—(Hospital Case No 785), F D, male, eleven and one-half months old, non-palpable mass Feeding—breast Condition on admission—? Type—ileo-cæcal Duration—5 days Operation to reduce Result—died Remarks—Ileum perforated before operation Ileostomy

CASE XXIII—(Hospital Case No 945), J F, male, seven months old, palpable mass Feeding—? Condition on admission—fair Type—ileo-cæcal Duration—thirty-seven hours Operation to reduce Result—recovered Remarks—History of attack two months ago Adhesions found Sutured to abdominal wall

CASE XXIV—(Hospital Case No 1251) S G, female, eight months old, palpable mass Feeding—? Condition on admission—fair Type—ileo-cæcal Duration—thirty-six hours Operation to reduce Result—recovered Remarks—Cæcum stitched to the abdominal wall

CASE XXV—(Hospital Case No 1250), G M F, male, six months old, palpable mass Feeding—breast Condition on admission—poor Type—ileo-cæcal Duration—four days Operation to reduce Result—died Remarks—Cæcum stitched to abdominal wall

CASE XXVI—(Hospital Case No 194), P G, female, six years old, palpable mass Feeding—? Condition on admission—fair Type—colic Duration—twenty-four hours Operation to reduce Result—recovered Remarks—Patient fell twenty-four hours before admission Mesentery sutured

CASE XXVII—(Hospital Case No 192), G R, male, seven months old, palpable mass Feeding—breast Condition on admission—fair Type—ileo-cæcal and colic Duration—eighteen hours Operation to reduce Result—recovered Remarks—Cæcum stitched to abdominal wall

CASE XXVIII—(Hospital Case No 1586), F B, female, six months old, palpable mass Feeding—breast and bottle Condition on admission—good Type—ileo-cæcal and colic Duration—twenty-four hours Operation to reduce Result—recovered Remarks—Cæcum stitched to abdominal wall

CASE XXIX—(Hospital Case No 808), M D F, male, five months old, palpable mass Feeding—breast Condition on admission—good Type—double Duration—two days Operation to reduce Result—recovered Remarks—Reduced by Brown's method

CASE XXX—(Hospital Case No 1363), A P, male, five months old, palpable mass Feeding—breast Condition on admission—fair Type—ileo-cæcal and colic Duration—four days Operation to reduce Result—recovered Remarks—Cæcum stitched to abdominal wall



CASE XXXI—(Hospital Case No 2356), M Z, male, four and one-half months old, palpable mass Feeding—breast and bottle Condition on admission—fair Type ileo-cæcal Duration—twelve hours Operation to reduce Result—recovered

CASE XXXII—(Hospital Case No 3170), G P, male, seven months old, palpable (?) mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—eighteen hours Operation to reduce Result—recovered Remarks—Ten inches of bowel involved

CASE XXXIII—(Hospital Case No 2936), R B, male, twenty-one months old, palpable (?) mass Feeding—breast and bottle Condition on admission—fair Type—ileo-cæcal Duration—two days Operation to reduce Result—recovered Remarks—Appendectomy

CASE XXXIV—(Hospital Case No 3159), E S, female, three and one-half months old, palpable mass Feeding—breast Condition on admission—poor Type—ileo-cæcal and colic Duration—sixty-three hours Irreducible operation Result—died Remarks—Extensive resection of gangrenous bowel Patient died a few hours later

The cæcum was sutured to the anterior abdominal wall in several cases, but these did no better than the others Only one case recurred and this was due to an adenoma of the descending colon, in a boy four years old His condition did not warrant a resection at the first operation, so the colon was sutured to the anterior abdominal wall after the reduction of the intussusception The intussusception recurred five weeks later and a Witzel enterostomy was done, as the patient's condition again did not warrant a resection Four days after the second operation the patient pulled out the catheter, which was reinserted, but the patient died from peritonitis

#### TABLE V

##### *Doctor Brown's Series*

CASE I—(Hospital Case No 562), G F, male, one year old, palpable mass Feeding—breast and bottle Condition on admission—good Type—ileo-cæcal Duration—forty-eight hours Operation to reduce, suture of ileum Result—recovered Remarks—Ileum sutured to abdominal wall

CASE II—(Hospital Case No 696) L D, female four and one-half months old, palpable (?) mass Feeding—breast Condition on admission—fair Type—ileo-cæcal Duration—forty-eight hours Irreducible operation Result—died Remarks—Ileum anastomosed to colon Intussusception left outside abdomen Died nine hours later

CASE III—(Hospital Case No 37), J L, male, seven months old, palpable mass Feeding—breast, three months Condition on admission—quite toxic Type—ileo-cæcal Duration—thirty-six hours Irreducible operation Result—recovered Remarks—Resection Murphy button anastomosis Eviscerated seventh day post-operative

CASE IV—(Hospital Case No 414), M B, male, four months old, palpable mass Feeding—breast Condition on admission—very toxic Type—ileo-cæcal Duration—three days Irreducible operation Result—died Remarks—Mass brought outside abdomen and drained Died in one hour Operation, twenty-five minutes

CASE V—(Hospital Case No 440), P D, male, seven months old, palpable mass Feeding—breast Condition on admission—toxic Type—ileo-cæcal Duration—four days Operation to reduce Result—died Remarks—Temperature, 107°, pulse, 136, respirations, 60 at death five and one-half hours after operation

CASE VI—(Hospital Case No 75), M S, female, eleven months old, non-palpable mass Feeding—breast Condition on admission—very toxic Type—ileo-cæcal Duration—four days Operation to reduce Result—died Remarks—Temperature, 105°, pulse, 158, respirations, 60 at death ten hours after operation Bowel good

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CASE VII—(Hospital Case No 361), B B, male, one year old, palpable mass, Feeding—breast, nine months Condition on admission—toxic Type—ileo-cæcal Duration—five days Irreducible operation Result—died Remarks—Ileo-colostomy Lived seven hours

CASE VIII—(Hospital Case No 222), F G, male, four months old, palpable mass Feeding—breast Condition on admission—very toxic Type—ileo-cæcal Duration—three days Irreducible operation Result—died Remarks—Resection Anastomosis

CASE IX—(Hospital Case No 26), H B, female, eight and one-half months old, palpable mass Feeding—? Condition on admission—good Type—ileo-cæcal Duration—twenty-four hours Operation to reduce Result—recovered Remarks—Appendectomy Cæcum sutured to abdominal wall

CASE X—(Hospital Case No 300), W B, male, nine months old, palpable mass Feeding—breast Condition on admission—fair Type—ileo-cæcal Duration—three days Operation to reduce Result—died Remarks—Diarrhœa and bloody stools for one month Died six hours after operation Temperature, 105°, pulse, 148, respirations, 54

CASE XI—(Hospital Case No 423), M R female, ten months old, non-palpable mass Feeding—breast, six months, bottle, four months Condition on admission—good Type—mid-ileum Duration—twenty-five days (?) Operation to reduce Result—died Remarks—Intussusception easily reduced Poor reaction Died in twelve hours post-operative

CASE XII—(Hospital Case No 647), E M, female, five months old, palpable mass Feeding—? Condition on admission—good Type—ileo-cæcal Duration—three days Operation to reduce Result—died Remarks—Temperature, 106°, pulse, 148, respirations, 36, at death in seventy-two hours

CASE XIII—(Hospital Case No 378), J C, male, three months old, non-palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—forty-eight hours Operation to reduce Result—died Remarks—Temperature, 107°, pulse, 140, respirations, 60, at death five hours post-operatively Poor reactions

CASE XIV—(Hospital Case No 259), R N, male, four months old, non-palpable mass Feeding—breast Condition on admission—fair Type—ileo-cæcal Duration—six days Irreducible operation Result—died Remarks—Resection, anastomosis Died in shock

CASE XV—(Hospital Case No 189), D R, male, one year old, non-palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—twenty-four hours Operation to reduce Result—recovered Remarks—Developed diphtheria

CASE XVI—(Hospital Case No 180), A K, female, ten months old, palpable mass Feeding—breast, six months, bottle, four months Condition on admission—fair Type—ileo-cæcal Duration—five days Irreducible operation Result—died Remarks—Ileostomy Died from shock Time of operation, twenty minutes

CASE XVII—(Hospital Case No 328), M T, male, six months old, palpable mass Feeding—? Condition on admission—good Type—ileo-cæcal Duration—forty-eight hours Operation to reduce Result—died Remarks—Fæcal vomiting next day Died forty-eight hours post-operatively Cæcum sutured to anterior abdominal wall Operation, twenty-five minutes

CASE XVIII—(Hospital Case No 281), D P, male, eight months old, palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—five days Irreducible operation Result—died Remarks—Resection Murphy button anastomosis Ileostomy above anastomosis Died in one hour

CASE XIX—(Hospital Case No 217), S C, male, ten months old, palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—twenty-four hours Operation to reduce Result—died Remarks—Papilloma resected from terminal ileum Lived sixty hours Operation, twenty minutes

CASE XX—(Hospital Case No 734), L D, female, four months old, palpable mass Feeding—? Condition on admission—poor Type—ileo-cæcal Duration—twenty-four hours Operation to reduce Result—died Remarks—Died one hour after operation Temperature, 103°, pulse, 136, respirations, 48

CASE XXI—(Hospital Case No 760), G C, male, six months old, palpable mass Feeding—? Condition on admission—poor Type—ileo-cæcal Duration—forty-eight hours Reduction not attempted Result—died Remarks—Constipation, vomiting, bloody stool and convulsions Died as operation was started

CASE XXII—(Hospital Case No 797), A B, female, five months old, palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—twelve hours Operation to reduce Result—lived Remarks—Anchor suture to anterior abdominal wall

CASE XXIII—(Hospital Case No 430), H H, male, six months old, palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—three days Operation to reduce Result—died Remarks—Mass palpable in rectum Easily reduced Operation eighteen minutes

CASE XXIV—(Hospital Case No 309), J D, male, eight months old, palpable mass Feeding—? Condition on admission—fair Type—ileo-cæcal Duration—eight hours Operation to reduce Result—lived Remarks—Anchor suture to anterior abdominal wall Time of operation, ten minutes

CASE XXV—(Hospital Case No 777), A A, male, six months old, palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—twenty-four hours Operation to reduce Result—lived Remarks—Appendectomy Anchor suture

CASE XXVI—(Hospital Case No 800), R C, male, four months old, palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—twenty-four hours Operation to reduce Result—died Remarks—Mass extended to rectum Difficult to reduce Appendectomy Anchor suture Left table in good condition At death temperature, 105°, pulse, 166, respirations, 68

CASE XXVII—(Hospital Case No 9), A I, female, six years old, palpable mass Condition on admission—good Type—mid-ileum Duration—twenty-four hours Operation to reduce Result—recovered Remarks—Dark red cauliflower tumor, the intussusception, in mid-ileum, reduced No biopsy Tumor was hæmangiosarcoma

CASE XXVIII—(Hospital Case No 243), M V, female, eight months old, palpable mass Feeding—bottle Condition on admission—good Type—ileo-cæcal Duration—thirty-six hours Operation to reduce Result—lived Remarks—Anchor suture

CASE XXIX—(Hospital Case No 351), R S, male, nine months old, palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—three days Operation to reduce Result—lived Remarks—Intussusception to splenic flexure Easily reduced, and anchor suture to abdominal wall

CASE XXX—(Hospital Case No 469), R C, female, seven months old, palpable mass Feeding—breast Condition on admission—good Type—ileo-cæcal Duration—thirty-two hours Irreducible operation Result—died Remarks—Constriction incised as described in text

CASE XXXI—(Hospital Case No 549), S T, male, six years old, palpable mass Condition on admission—good Type—ileo-cæcal Duration—fifteen days Operation to reduce Result—lived Remarks—Congenital deformity of bowel

CASE XXXII—(Hospital Case No 525), R C, male, six months old, palpable mass Feeding—breast Condition on admission—good Type—? Duration—five weeks Operation—? Result—lived Remarks—Mass felt 3 centimetres within rectum Operative permission refused Colic, bloody stools, loss of weight for five weeks Improved Left hospital against advice

One patient progressed well, and had the stitches removed on the fifteenth day after operation Some hours later the abdominal wound separated and the

intestines were eviscerated. To replace the intestines a general anæsthetic had to be given, and the patient died of shock following this procedure. This is not an uncommon complication following these operations in children, and it should be anticipated by using meticulous care in the closure of the wound in the abdominal wall.

Since the above accident, we have used mattress stay sutures fastened over small rubber tubes (Quill suture) to prevent cutting of the skin. The stitches are left in for ten or twelve days and when they are removed the wound is strapped with sterile adhesive on the skin. This is the routine method used by Lee in closing the abdominal wounds in infants. In one case there was a history of a similar previous attack two months before, and at operation adhesions were found between the ileum and the cæcum. In this case the cæcum was stitched to the abdominal wall after reduction. One case was operated on two hours after onset, and two cases were operated on the same afternoon. The fact that nearly all of the cases which we see early are referred by younger men who have had special training in pædiatrics promises well for a still further decrease in the operative mortality in the future.

In this series there were twenty males (59 per cent) and fourteen females (41 per cent) which corresponds with the published statistics. For the privilege of reporting these cases I am indebted to Doctors Hodge, Jopson, Lee, Speese and Brown.

Brown in his paper<sup>1</sup> referred to a method of incising the constricted ring of the intussusception which he used when reduction was impossible and when the bowel was not gangrenous. For details of this, those interested are referred to that paper.

I wish here to put on record, with Doctor Brown's permission, one case in which he successfully used this method. The patient, a five months' old male, was admitted in good condition, with a tumor palpable by rectum. The symptoms were of two days' duration. At operation the intussusception was not reducible, and as the bowel was not gangrenous, a longitudinal incision was made in the anti-mesenteric border of the cæcum, releasing the constriction. The intussusception was reduced, the incision was sutured and the patient made a normal convalescence. O. D. Johnson<sup>2</sup> has since reported a somewhat similar procedure. In a two-year-old child where complete reduction was not possible, it was accomplished by a longitudinal incision which penetrated only the serous and muscular coats of the bowel.

Our knowledge of intussusception is of long standing. John Hunter<sup>3</sup> ably described the mechanism and anatomy of intussusception. Paul Barbette,<sup>3</sup> a surgeon of Amsterdam, in 1676, definitely suggested opening the abdomen in obstinate volvulus or intussusception. In 1871, Jonathan Hutchinson<sup>3</sup> successfully treated intussusception by laparotomy. In 1888, A. E. Barker put the treatment on a rational basis by recommending early operation.

Resections were not favorably looked upon, for C. H. Fagge,<sup>4</sup> in 1906, said "I believe there is no recorded case of recovery under one year." Soutar, in a lecture on "Intussusception" republished in the British Medical Journal in 1913 said, "Resection is

attractive but unjustifiable unless gangrene is present, for there is no recorded case of an infant under one year surviving this operation"

W H C Romanis<sup>5</sup> in 1918 wrote "If, however, an irreducible intussusception occurs in a younger child, one or two years of age, the outlook is altogether different, for recovery is practically unknown in a child of this age and the operation is well regarded as hopeless

C W Peterson<sup>6</sup> in 1905 reports the first successful resection in intussusception in this country The earliest case was reported by Clubbe in 1896<sup>3</sup>

In 1910, Fairbanks and Vickers<sup>7</sup> performed a successful resection for intussusception in a child of seven months

In 1912, Charles Dowd<sup>8</sup> of New York resected about one-third of the colon, and performed a side-to-side anastomosis for irreducible (not gangrenous) intussusception in a child five days old This is the youngest case that we have been able to find, where resection was successfully done for intussusception, and it occurred to the writer that the type of operation suggested by Brown might have been applicable in this case, since the bowel was not gangrenous

Jopson, in 1916, reported a successful resection and anastomosis of the bowel, in a child seven months old, by means of a Murphy button

In 1921, Clubbe<sup>3</sup> had collected sixteen cases of recovery after resection, and since that time other cases have been reported

We believe at every operation for intussusception facilities should be at hand to perform resection should it be found necessary, for in the last thirty-four intussusceptions in the Children's Hospital there have been three resections with two recoveries

The case to be reported, G W H, Jr, a seven weeks' old white male, was admitted to the Children's Hospital on October 19, 1925, to the service of Doctor Lee

The chief complaint was vomiting and bloody stools The family history was unimportant, and the child was a full-term, breast-fed baby He was well until thirty-six hours before admission, when he vomited and had a bloody bowel movement Later he passed small amounts of blood The child was well-developed, but acutely ill A mass was palpable in the left lower abdomen, which was also palpable by rectal examination, 2 centimetres from the anus Bloody mucus was present on the examining glove Without delay, under ether anaesthesia, an incision, 7 centimetres in length was made just to the left of the mid-line On opening the peritoneal cavity bloody fluid escaped, and a sausage-shaped mass about 18 centimetres in length was delivered into the wound About 8 centimetres were reduced with difficulty, and, on further effort, the descending colon ruptured into its mesentery The irreducible mass which consisted of the lower end of the ileum, appendix, caecum, ascending, transverse and most of the descending colon, was resected, the greater part of which was gangrenous An end-to-side anastomosis was performed, the end of the lower colon or sigmoid was sutured to the side of the lower ileum, linen sutures being used throughout After completion of the anastomosis it was noted that a portion of the pouch of the ileum distal to the anastomosis was becoming dark, due to insufficient blood supply, so an additional 3 centimetres of the ileum were resected and again inverted, the anastomosis having been high enough to permit this A cigarette drain was inserted and the abdomen closed The operation lasted about one hour The child's condition was critical and stimulants were administered Cultures from the abdominal fluid showed staphylococcus albus, diphtheroids, and bacillus vulgaris

On the following day the child had no bowel movement and was very toxic On the third day there was no vomiting and the child had several bowel movements On the sixth day, when the drain was removed, there was some drainage from the incision, and some vomiting The stitches were removed on the twelfth day and the wound gradually healed The bowel movements, which were normal, averaged about three daily The patient continued to gain in weight and was discharged on December 13, 1925, fifty-five days after admission The child was seen again about two weeks later,

## ACUTE INTUSSUSCEPTION

in good condition and gaining in weight. As the family then moved, the patient could not be traced any further.

This was the most extensive successful resection for intussusception in a patient of this age that we have been able to find in our review of the literature.

### SUMMARY

(1) The surgical treatment of intussusception can be divided into three groups: (a) Easily reducible when no further surgery is indicated, (b) the irreducible, without gangrene, when we recommend the operation suggested by Brown, or the modification suggested by Johnson, (c) The irreducible and gangrenous, when we recommend resection and immediate anastomosis.

(2) Successful resection for intussusception is not so rare as is generally believed, and probably should be done more frequently before the bowel is subjected to too much trauma.

(3) The case reported, from our search of the literature, seems to be the most extensive successful resection for gangrene in intussusception yet reported in a child seven weeks of age.

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# MASSIVE RESECTIONS IN ACUTE MECHANICAL INTESTINAL OBSTRUCTION

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THIS series of experiments was suggested by a case seen last year at the Church Home and Infirmary, in which obstruction was due to a band of adhesions following a pelvic operation. Upon opening the abdomen of this patient, who had been obstructed for six days, it was found that the bowel wall at the point of obstruction showed marked gangrene. It was so badly damaged over a space of ten to twelve inches that we felt that even if enterostomy were done above this point, the patient would still die from peritonitis due to rupture of the bowel below it. Yet it was not felt that the patient's condition warranted any massive resection. Therefore, it was thought best to extra-abdominalize the gangrenous portion of the bowel together with enough bowel above this point to be sure of free drainage without rupture into the peritoneal cavity. This was done in a few minutes and the patient left the table with very little change in her general condition.

During her convalescence practically all the bowel on the abdominal wall sloughed off, leaving a terminal ileostomy. She was put on high-caloric diet and in general built up so that at the end of six or eight months she had gained considerable weight and was in very good condition, her convalescence as a whole having been quite smooth. At the end of ten months, lateral anastomosis was done with no difficulty and she again had an uninterrupted convalescence.

On looking back we felt sure that a quick resection of the length of the bowel which we had made extra-abdominal would not have embarrassed her chances on the operating table and would have hurried her convalescence even though we felt that she would not have stood the lateral anastomosis at this time.

With this case in mind it occurred to us that it would probably be much better in the average case of acute mechanical obstruction if resection of the damaged bowel was done far enough back to make a lateral anastomosis possible at the primary operation, if the patient's condition warranted such a procedure. Upon looking up the literature on this subject it was found that, while many men advocated resection of the bowel in such cases, the point of resection, as well as the exact type of case in which resection would be indicated, was very indefinite. If one looks through the reviews on intestinal obstruction, he will find that no account is taken of the age of the patient, the duration of the obstruction, the exact cause, exact position of the obstruction, and the general condition of the patient at the time of operation in computing mortality rates. Also, it is very seldom stated how much

bowel was removed and never stated in exact terms how to choose the point for resection. As far as we can find there has been no exact experimental work done in this particular line. Scholefield<sup>1</sup> advocated "resection where practicable of any length of bowel seriously involved," but gave no experimental work to back up his suggestion nor any means of telling to what point the bowel was damaged. Murphy and Brooks<sup>2</sup> say "In surgical treatment of cases of intestinal obstruction, that part of the intestine with a mucous membrane which has been so damaged as to permit of abnormal absorption should be resected rather than drained." But again they give no exact data to back up their statement. Considering these points, we thought it would be interesting to perform some exact experimental work to determine whether dogs would stand massive resections after having been obstructed for four or five days, so far as the actual operation is concerned, and to see if we could greatly reduce the mortality rate by this procedure. We felt also that it was essential to try to determine, with some degree of exactness, a method of telling where the bowel would stand resection and lateral anastomosis without the usual sequence of leakage and peritonitis. We thought that if the dogs would stand primary operating, we would have accomplished two very important principles. First, that we would have totally removed the damaged bowel together with its toxic fluid, thereby preventing the possibility of absorption and of leakage from late rupture which often follows after damage, such as is accomplished through ileostomy. Secondly, that we would give free drainage to the loops above the point of obstruction without loss of fluids and intestinal secretions, which is at present considered one of the greatest contributing factors in death from obstruction following ileostomy. Of course, by this means we would also save the patient a second operation. Dr. H. B. Stone felt that the removal of the large segment of damaged intestine was much better than drainage if it could be accomplished. He thought that a large amount of toxin is contained in the damaged bowel wall and that this is rapidly absorbed following release of tension, and, therefore, could not possibly be influenced by ileostomy.

Accordingly, experiments were undertaken to determine these points, *viz.*, mortality with primary massive resection, a specific means of determining a point where resection is safe, and if there actually is toxin present in the damaged bowel wall.

*Experimental technic*—Medium-sized mongrel dogs were used throughout the experiments and in the first series were given morphia grains  $\frac{1}{4}$  and intratracheal ether. Under sterile technic, the abdomen was opened through a right rectus incision, and the ileum transected eighteen inches above the ileocaecal valve. The ends were inverted by the Parker-Kerr method and reinforced with three silk mattress sutures. The centre mattress suture was left long on each of the ends so that the two inverted ends could be tied together to prevent intussusception. The abdomen was then closed in layers with silk and the dogs allowed to remain completely obstructed for periods of two, four, five, and in one case six days. Not much attempt was made to go beyond the five-day period because we were losing better than 50 per cent of the dogs before we even had a chance to perform the second operation, and we felt that since our results on the dogs which



actually lived to undergo the second operation were 100 per cent, it was of no advantage to waste more dogs

At the end of the chosen period the dog was again anesthetized but given as little ether as possible and no morphia, because we lost four or five dogs on the table during the induction period. This gives a fair idea as to how sick they were at the end of five days. The abdomen was again opened through the same incision or sometimes through a left rectus and the point of obstruction exposed and brought out on the abdominal wall. Resection of segments of the damaged intestine was then carried out of anywhere from as little as eight to ten inches in some of the two-day dogs to as much as forty-six inches in one of the five-day dogs, depending upon the extent to which the bowel wall was damaged. Resection was done as quickly as possible by clamping the mesenteric vessels near their base and dividing them between clamps. By this means resection of the whole loop could be done in three or four minutes and with no apparent reaction on the part of the animal. We feel that this is an important point.

The open end of the resected intestine was then inverted by the Parker-Kerr method and well reinforced and a lateral anastomosis done under as careful aseptic technic as possible. Small rubber-shod clamps were used and closed as lightly as possible to prevent damage to the bowel wall, as we feel that infection plays a very large part in leakage of anastomoses following resection. The lumen of both segments of bowel was very carefully washed out with salt solution and then with ether, and after having laid one complete layer of sutures, instruments and dressings were changed and the bowel wall again washed with ether so that the second layer of sutures was fairly clean. In some of the earlier cases this was not done and the difference between the reaction around the anastomosis definitely proves that this was of value because even in some of the dogs that had gone five days the reaction was much less than that of the two-day series. The anastomoses were made with silk throughout. Following completion of resection and anastomosis, the abdomen was closed in layers with silk.

In Dogs S1 to 20 the diet was the regular kennel diet of bread and boiled lungs both before and after operation. In Nos 21 to 30 an attempt was made to standardize the pre-operative and post-operative diet by feeding the dogs nothing but milk for three to four days before operation and for three weeks following operation. This was done because we were getting such irregular results. In the first stage some of the dogs died at forty-eight to seventy-two hours following obstruction, and from then on up to five days, so that the immediate mortality was running around 50 per cent, making it quite difficult to get dogs to live long enough to do the second stage, especially since some of the ones that lived five days were so sick that we lost them during induction anesthesia. However, this change in diet did not seem to help any as the mortality remained the same.

TABLE I (PART I)

*Immediate and Final Results of Massive Resections*

Dog Obstruction 4. Duration of obstruction—two days. Immediate results—lived. Length of resection—eight inches. Final results—lived, sacrificed thirty-one days post-operative. Length of bowel left—fifty-two inches. Condition—good.

Dog Obstruction 5. Duration of obstruction—two days. Immediate results—lived. Length of resection—ten inches. Final results—died five days later. Perforation, re-obstruction, kink.

Dog S2. Duration of obstruction—two days. Immediate results—lived. Length of resection—ten inches. Final result—died twenty-four hours later. Leak, peritonitis.

Dog S3. Duration of obstruction—two days. Immediate results—lived. Length of resection—eleven inches. Final results—lived, sacrificed twenty-six days post-operative. Length of bowel left—forty-six inches. Condition—good.

Mortality rate for Part I, 50 per cent

# MASSIVE INTESTINAL RESECTIONS

## PART II

Dog S4 Duration of obstruction—four days Immediate results—lived Length of resection—twenty-four inches Final results—lived, sacrificed fourteen days post-operative Length of bowel left—thirty-nine inches Condition—good

Dog S1 Duration of obstruction—four days Immediate results—lived Length of resection—twenty-one inches Final results—lived, sacrificed twenty-four days post-operative Length of bowel left—forty-eight inches Condition—fair

Dog Obstruction 7 Duration of obstruction—four days Immediate results—lived Length of resection—twenty-four inches Final results—lived, sacrificed thirty-four days post-operative Length of bowel left—forty-six inches Condition—good

Dog S5 Duration of obstruction—four days Immediate results—lived Length of resection—twenty-six inches Final results—died eleven days post-operative Reobstructed Length of bowel left—thirty-eight inches Condition—poor

Dog S6 Duration of obstruction—four days Immediate results—lived Length of resection—thirty-five inches Final results—lived, sacrificed thirty-three days post-operative Length of bowel left—forty-three inches Condition—good

Dog S7 Duration of obstruction—four days Immediate results—lived Length of resection—thirteen inches Final results—lived, sacrificed twenty-six days post-operative Length of bowel left—forty-six inches Condition—good

Mortality rate for Part II, 16.66 per cent

## PART III

Dog S9 Duration of obstruction—thirty-six hours Immediate results—died, distemper, pneumonia

Dog S10 Duration of obstruction—five days Immediate results—lived Length of resection—thirty-three inches Final results—lived, sacrificed twenty-one days post-operative Length of bowel left—fifty-six inches Condition—excellent

Dog S11 Duration of obstruction—five days Immediate results—died, perforation of loop, peritonitis

Dog S12 Duration of obstruction—five days Immediate results—lived Length of resection—seventeen inches Final results—lived, sacrificed ninety days post-operative Length of bowel left—seventy inches Condition—excellent

Dog S13 Duration of obstruction—three days Immediate results—died, ruptured loop, peritonitis

Dog S14 Duration of obstruction—five days Immediate results—died, induction anaesthesia

Dog S15 Duration of obstruction—four days Immediate results—died, from obstruction, no pneumonia, no leakage

Dog S16 Duration of obstruction—three days Immediate results—died, distemper, pneumonia

Dog S17 Duration of obstruction—four days Immediate results—died, rupture of loop, peritonitis

Dog S18 Duration of obstruction—five days Immediate results—lived Length of resection—forty-three and one-half inches Final results—died, distemper and pneumonia fourteen days post-operative Length of bowel, thirty inches Condition—no inanition

Dog S19 Duration of obstruction—three days Immediate results—died, obstruction, lung and peritoneum clear

Dog S20 Duration of obstruction—three days Immediate results—same as S19

Dog S21 Duration of obstruction—five days Immediate results—died, induction anaesthesia

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Dog S22 Duration of obstruction—five days Immediate results—died, induction anæsthesia, no peritonitis

Dog S23 Duration of obstruction—five days Immediate results—lived Length of resection—thirty-two and one-half inches Final results—lived, sacrificed sixty-three days post-operative Length of bowel left—seventy inches Condition—fair

Dog S24 Duration of obstruction—five days Immediate results—died, induction anæsthesia, no peritonitis

Dog S25 Duration of obstruction—five days Immediate results—lived Length of resection—forty-six inches Final results—lived, sacrificed sixty-three days post-operative Length of bowel—eighty-eight inches Condition—fair

Dog S26 Duration of obstruction—five days Immediate results—died, obstruction, lungs and peritoneum clear

Dog S27 Duration of obstruction—six days Immediate results—died, ruptured loop, peritonitis

Dog S28 Duration of obstruction—five days Immediate results—died, obstruction, lungs and peritoneum clear

Dog S29 Duration of obstruction—three days Immediate results—died, gangrene, ruptured loop

Dog S30 Duration of obstruction—six days Immediate results—lived Length of resection—thirty inches Final results—died, fourteen days post-operative, emaciation, partial obstruction Length of bowel left—forty-two inches

### *Summary of Mortality Rates*

Series No	Mortality Rate
(1) Two-day	50 per cent
(2) Four-day	16.66 per cent
(3) Five-day	00 per cent

It will be seen from the above table that the percentage of mortality is in inverse proportion to what one would expect, being much higher in the two-day series than in the four- or five-day series. This, we feel, is due purely and simply to the fact that during the first few cases we had no definite means of telling where resection would be safe, and, therefore, made the usual error of not removing enough bowel, since in the dogs that died death was due to leakage and subsequent peritonitis. At this point, also, our careful technic of lateral anastomosis had not been developed. We did not think that it was necessary to go back and repeat these experiments to prove this point because, after having got 100 per cent results in the five-day series, it was felt that our original idea was sufficiently substantiated. We do not think that there is any question about the fact that the improvement in our results from the two- to the five-day period was due entirely to improvement in our ability to recognize the point at which resection of the bowel is safe together with the improvement of our technic in doing the anastomosis. Probably the point of resection was the largest factor by far, but still the difference in reaction around the anastomoses where the usual technic was used and that where the careful technic was used was enough to justify the routine use of the latter. Another important point brought out is the fact that these dogs stood ether anæsthesia very poorly and morphia was definitely

contra-indicated. Probably avertin with nitrous oxide or ethylene or even local anæsthesia with a little ether would be much better in the clinical case.

Another very important point to be considered is how much bowel can be removed with safety to the patient from a nutritional viewpoint. It will be seen from the table that in some cases almost half the total length of the small intestine was removed from some of these dogs without much apparent effect on their nutrition post-operatively. However, this seems to be somewhat of a variable factor, as in the last two dogs of the five-day series only about one-third of the total length of the bowel was removed and these dogs had still not regained their normal weight after a little over two months following operation. This is about comparable to what is reported in the literature to be true of human cases where E. R. McGuire<sup>3</sup> reports removal of eleven feet with normal nutrition, with the exception of some early diarrhoea following operation, and in reviewing the literature finds twenty-one cases reported where 300 to 524 centimetres were removed without fatal results. Therefore, as long as one stays under ten to eleven feet there need not be much fear of nutritional disturbance.

This brings us to the point of how to determine where resection of the obstructed bowel is safe. The more experiments we did the harder we felt this point was to determine with any degree of exactness. We felt that the best things to judge by were first, the ability of the bowel to contract when mechanically stimulated, that is, not only ability to contract but to contract completely, go into actual spasm. This spasm is readily induced by tapping the bowel with a clamp or pinching it or plucking it with the finger. It is important to notice whether this bowel at the height of its contraction comes down to the size that one would expect normal bowel to reach under similar stimulation, because this helps to determine the degree of œdema which is the best expression of the early reaction of the bowel to obstruction.

Secondly, the circulation of the bowel wall and the mesentery is very important. There should not be any œdema of the mesentery, and pulsations should be clearly seen and felt in the mesenteric vessels. The circulation in the bowel wall itself is best determined by its color during both spasm and relaxation. During relaxation a point should be picked where the color of the bowel wall changes from the dusky, non-glistening color of damaged circulation to a point as near the normal pinkish glistening color as possible. This point is very hard to determine as the change is a very gradual one and the normal color is never actually reached. One has to be governed by the comparison and by experience, together with the other points that we have brought out. The bowel wall at the point of resection when in the spastic stage should be nearly white in color showing that the capillaries are not thrombosed, since the blood is expressed from them by the force of the contraction. In obstructed bowel where the circulation is damaged and there is beginning gangrene, even though the bowel will contract it remains rather dusky in color, probably due to thrombosed capillaries.

Thirdly we found that in suturing obstructed bowel wall the needle meets

increasing resistance as one goes from badly damaged bowel wall toward that which is approximately normal, and this is one of the tests that we use to determine a suitable point. We feel that this is due to œdema of the submucosa since this layer is the layer that causes resistance to the passage of the needle. This œdema is depicted in Fig 2 later in the article. In doing the anastomosis there is always, even at the point of resection, some difference between the resistance to the passage of the needle through the wall of the upper and of the lower segment. This shows that even where anastomoses will hold and resection is safe this œdema still persists to some extent.

At this point the microscopical pathology of obstructed intestinal wall

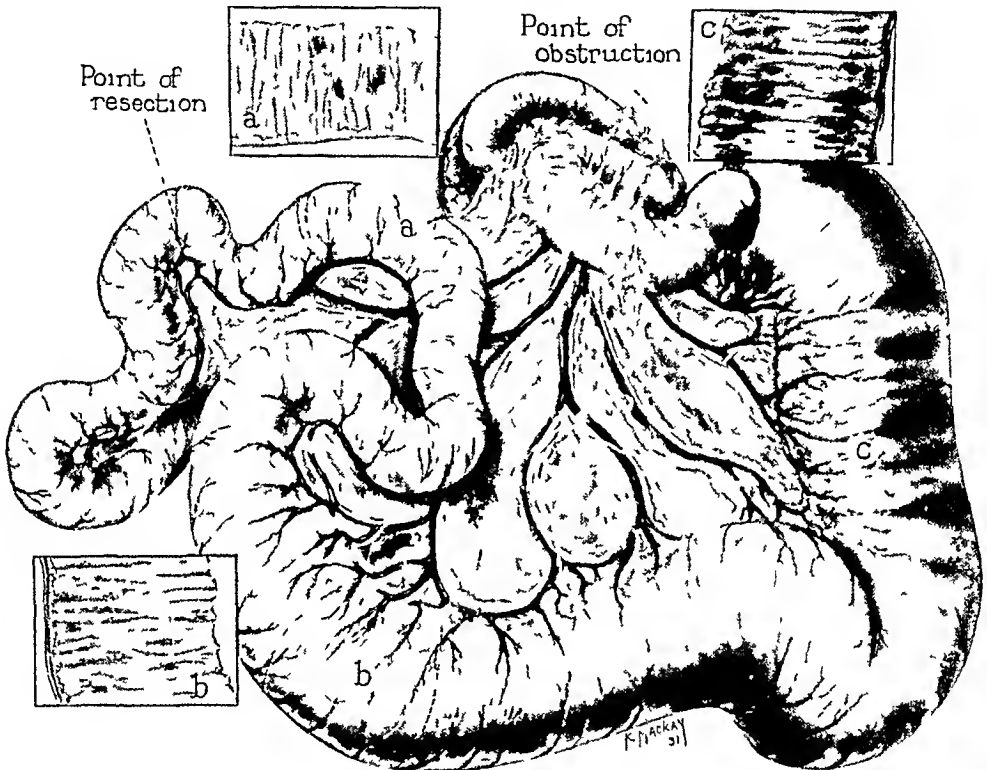


FIG 1—Dog S25 Showing condition of bowel at time of resection, five days completely obstructed

might well be discussed. Fig 2 is a microphotograph of segment C of Fig 1. It shows, as can be readily seen, very marked œdema of all the layers of the intestinal wall but particularly of the muscular layers and of the submucosa with some slight cellular infiltration. We think that there is no question that this œdema, together with the very great increase in number of organisms in the lumen of the bowel, are the chief factors that have made resections leak following lateral anastomosis in such cases. It is certainly the failure to perceive these factors that has made mortality in these cases so high. If there is any uncertainty in the mind of the operator as to the point where this œdema and reaction have decreased to such an extent as to make resection safe, he had best by all means err on the side of safety and

make his resection several feet higher than there is any real necessity for, rather than to make it at a point of uncertainty. It is surely this combination of infection together with œdema around the sutures that allows leakage, and the leakage reacting in partially devitalized œdematous tissue that makes increased leakage ending in peritonitis and death. The contrast between badly damaged bowel and bowel where resection is safe is clearly shown in the difference between Figs 2 and 3. In Fig 3 there is very little œdema present so that in spite of the fact that the number of organisms in the lumen of the gut is probably the same in both cases, this bowel will hold sutures since its strength and circulation are good enough to overcome the invasion of the organisms. Because of these factors careful choice of the point of resection and careful technic in performing the operation are absolutely essential to success.

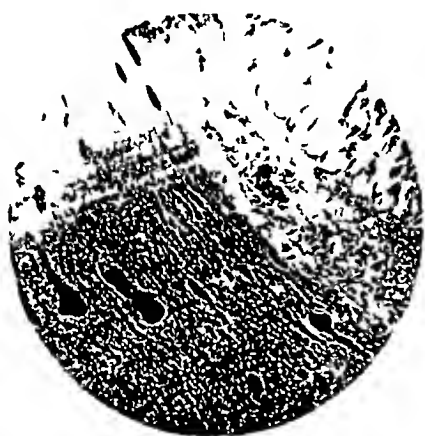


FIG 2



FIG 3

FIG 2—Microphotographs of sections taken from segment C of Fig 1, showing marked œdema of whole bowel wall, but particularly of submucosa and muscularis.

FIG 3—Microphotograph of sections taken from segment A of Fig 1, showing marked contrast of bowel wall at point of resection to bowel wall in Fig 2. Very little œdema present.

TABLE II

*Results of Intravenous Injection of Filtrate from Mucosal Scrapings*

Dog S31 Duration of obstruction—three days Reaction (A) above—S31 (A), 10 cubic centimetres, mild, howled once, staggered, one spasm, urinated (lived) Reaction (B) below—S31 (B), no apparent reaction, lived

Dog S32 Duration of obstruction—three days Reaction (A) above—S32 (A), 10 cubic centimetres, marked reaction, passed water and faeces, howled, rolled over and over, unconscious for several minutes, staggered and very weak for five minutes, gradual return to normal (lived) Reaction (B) below—S32 (B), 10 cubic centimetres, no reaction of any sort, lived

Dog S33 Duration of obstruction—three days Reaction (A) above—S33 (A), 10 cubic centimetres, very marked general reaction. On the whole exactly as S32 (A) Died in twenty-four hours Reaction (B) below—S33 (B) No reaction

Dog S34 Duration of obstruction—three days Reaction (A) above—S34 (A), 10 cubic centimetres, very marked general reaction. Died within twelve hours Reaction (B) below—S34 (B) Equally marked general reaction, lived

Dog S35—(Dog had been dead twelve to twenty-four hours) Duration of obstruction—three days Reaction (A) above—S35 (A), 10 cubic centimetres, marked

general reaction, lived      Reaction (B) below—S35 (B)      Equally marked general reaction, lived

To determine if there was actually any basis for the assumption that the œdematous partly devitalized bowel wall of obstructed intestine contains any toxin, the following series of experiments were performed. Five dogs were given morphia grains  $\frac{1}{4}$  and intra-tracheal ether, and under sterile technic a right rectus incision was made. They were then obstructed by transverse section of the ileum twenty-four inches above the ileocecal valve by the Parker-Kerr inversion of the ends, reinforced with mattress sutures of silk. The abdomen was then closed and the dogs allowed to remain obstructed for three days, at which time they were sacrificed and twelve inches of bowel taken from immediately above and twelve inches from immediately below the point of obstruction. This bowel was opened longitudinally and carefully washed through four washings of tap water. Then all the mucus and other material which had adhered to the mucosa was scraped off and the mucosa again washed through tap water. After this the mucosa was scraped completely off down to the sub-mucosa. The material thus obtained was ground in a porcelain mortar with twenty cubic centimetres of normal salt solution and allowed to stand fifteen minutes. The solution was then strained through gauze to get rid of the larger particles and the remainder centrifuged.

The same procedure was carried out on both segments of bowel in each of the five dogs. Ten cubic centimetres of the supernatant fluid were injected intravenously into each of ten dogs. The reactions of these dogs to the injection can be seen from Table II. It will be noted that on the whole the reaction is very much more marked in those dogs that received the solution obtained from extracted mucosa taken from above the point of obstruction both as to early and late results. While in the last two dogs the immediate reaction was practically the same in both cases, in the first case the dog receiving the extraction fluid from above the point of obstruction died, whereas the other lived, and in the last dog both reactions might be questioned because the dog from which the solutions were made had been dead from twelve to twenty-four hours.

No further experiments in this regard were attempted because we felt that the whole series was open to question in that it is practically impossible to exclude the chance of there having been some toxic material contained between and around the villi of the mucosa in spite of the careful washing process. It is now felt that it would have been better in view of the tremendous œdema and the increase in tissue fluid of the obstructed loops to have used the muscularis and sub-mucosa for the extraction process rather than the mucosa. This would have eliminated the chance of contamination from immersion in toxin to which the mucosa was subject. We feel that ample proof of the theory that toxin is actually present in the œdematous bowel wall has been obtained, but will later repeat the experiments with extracts from the muscularis and the sub-mucosa for our own satisfaction.

#### SUMMARY

It is interesting to note the remarkable variation in reaction of these animals to a perfectly stereotyped procedure, such as was done in obstructing them. They died in from three to six days, some showing marked gangrenous changes in the bowel wall with leakage in three days, others with no leakage or only beginning gangrene in five days. Attempt was made to standardize their intestinal contents by a routine diet, but with no effect on this factor.

## MASSIVE INTESTINAL RESECTIONS

at all. This seems to be true of patients also, as some are quite sick in two to three days while others go six to seven days and still seem in fair condition.

We feel that in advocating massive resections, whenever possible, we are adhering to the surgical principle of ridding the body of tissue that is damaged beyond hope of repair, together with its toxic products of degeneration and the chance of generalized peritoneal infection through late rupture. We have also obviated the chance of abnormal absorption by such damaged tissue. We have shown why one must take out much more bowel than seems necessary at first glance, and have given a fairly exact means of determining the point at which resection is safe. It is proven that, in spite of the general belief to the contrary, large resections can be done on very sick animals with practically no reaction and a low mortality rate if they are done quickly. There seems to be much more danger from the anæsthetic than from the operation. Therefore we recommend a very light anæsthesia, one of nitrous oxide and avertin, or ethylene and avertin as probably being the best. No morphia should be given.

In cases where the patient is *in extremis* and it is impossible to pick a point for resection due to the marked distention of the bowel, we feel that the extra-abdominalization of the involved bowel as was done in the case suggesting this work offers the best chance of a favorable outcome. Ileostomy should be done only where it is impossible to find the point of obstruction through the original incision and the patient is too sick to stand further exploration.

We wish to extend our hearty thanks to Dr. Harvey B. Stone for his helpful suggestions in this work.

### CONCLUSIONS

- (1) Massive resections are feasible on very sick animals, giving a very low mortality rate if done quickly and with careful technique.
- (2) The point at which resection is safe can be determined with a fair degree of accuracy if the principles brought out are adhered to.
- (3) There is toxin present in the oedematous, partially devitalized tissue of obstructed intestinal wall.
- (4) Obstructed animals stand general anæsthesia very poorly.
- (5) Reaction to obstruction is an extremely variable factor.

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# CONGENITAL DUODENAL ADHESIONS\*

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IN 1925, Neff and Haden,<sup>1</sup> of St. Louis, called attention to transduodenal adhesions of congenital origin, when they reported the autopsy findings in three children who died of vomiting from unknown cause. In 1926, Higgins and Patterson,<sup>2</sup> of England, reported a similar condition in a child which recovered following operation.

Congenital duodenal adhesions are an important clinical entity having a definite train of symptoms, and should be borne in mind particularly by those called upon to operate on infants.

Though the cause of congenital duodenal adhesions has received investigation, no one seems to have advanced a theory which adequately explains their formation. The adhesions may be the result of infection which originates from intra-uterine sources, traveling through or along the umbilical vessels, falciform ligament or portal vein to the under surface of the liver or subhepatic fossa. The adhesions in the six cases herein reported all extended from the anterior surface of the duodenum to the under surface of the liver in close proximity to the gall-bladder. The duodenum was pulled upward and to the right, producing definite kinking. The portion proximal to the adhesions was distinctly dilated, and as the adhesions were severed, the gas was seen to pass into the distal portion. The stomach was dilated in each instance and this dilatation also was relieved after separating the adhesions.

The symptoms of congenital duodenal adhesions are so similar to those of hypertrophic stenosis that one is led to this as a diagnosis, and when at operation no stenosis is found, one should explore the subhepatic fossa for the presence of adhesions. Up to the present time no one has emphasized the importance of adhesions as a cause of these well-known symptoms.

The chief subjective signs are vomiting, constipation, and loss of weight in a fretful, hungry and dehydrated infant, while objectively there are visible gastric peristalses.

The vomiting occurs immediately after birth. In the early stages liquids are rejected almost as soon as they are swallowed, while as time goes on, the stomach becoming dilated, vomiting does not occur for some time after feeding, and then may become cumulative as well as projectile. Bile is usually absent in the vomitus in the early stages, but a small amount may pass the obstruction and then the vomitus will be bile-stained. The lack of absorption accounts for the constant hunger, the persistent constipation and the progressive emaciation and dehydration.

As the stomach dilates and the loss of weight continues, gastric peri-

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\* Read before the Philadelphia Pediatric Society, February 10, 1931.

## CONGENITAL DUODENAL ADHESIONS

staltic waves become visible. Commencing in the left hypochondriac region, they pass across the epigastrium, culminating at the pyloric region. Occasionally, the waves may pass beyond, becoming lost under the liver. Since the stomach dilates slowly, early regurgitation rather than projectile vomiting is the rule.



FIG. 1.—Stomach pulled downward and to the left, pyloric ring taut, duodenum dilated proximal to adhesions which pass from duodenum to under surface of liver.

Röntgen-ray examination is not essential for a diagnosis, and its findings may, in fact, be misleading.

The condition is to be differentiated from pylorospasm, pyloric stenosis, and atresia of the duodenum. In *pylorospasm*, the vomiting occurs several days after birth, is never bile-stained, and under small doses of atropine sulphate and thick feeding, the child is carried slowly back to recovery. In *pyloric stenosis*, the infant usually gains normally in weight, the vomiting

occurs a week to ten days or more after birth, is immediately projectile, is never bile-stained, and later becomes retentive, the peristaltic waves from the beginning are hour-glass in type and markedly visible, while in infants with congenital duodenal adhesions there is at first a slight general peristaltic wave which later may become hour-glass in type, but is not so marked as in the stenotic pylorus. *Atresia* of the duodenum is a congenital malformation and the diagnosis is usually made at operation or at autopsy.

The treatment of congenital adhesions of the duodenum is surgical, and should be instituted before dehydration sets in and loss of weight occurs, and it may be stated as axiomatic that the earlier the diagnosis is made and operation resorted to, the greater is the chance of success. In our series of six cases which recovered, one was four days old, one was five days old, and one eight weeks old. Of the cases which died, one was three weeks old, one six weeks old, and one eight weeks old.

The pre-operative treatment should be directed toward restoration of the water balance by giving normal saline solution hypodermically, intravenously or intraperitoneally. The extremities are wrapped in cotton and bandaged. Hot-water bottles are placed under and around the infant upon the operating table to preserve body temperature and lessen operative shock. All details incident to the operation are made ready before the anæsthetic is commenced. Ether, in my hands, has proven the most satisfactory, although many surgeons prefer local anæsthesia.

The operation is performed as follows. After the peritoneal cavity is opened, through an upper right rectus incision, the stomach is immediately identified, and delivered into the wound. The pylorus is examined for any hypertrophy, if none exists the subhepatic region is explored and the adhesions identified. The adhesions are better visualized by gentle traction of the stomach to the left by the assistant and with a retractor which pulls the hepatic flexure and transverse colon to the left, while the operator retracts the liver upward and to the right. When the duodenum is brought into view, the adhesions will be seen extending from the liver in close proximity to the gall-bladder transversely to the duodenum, and at the same time, the adhesions are made taut, divided with scissors and blunt dissection. As the adhesions are freed, and the obstruction released, one sees the distal duodenum fill, gas passes onward, and the proximal dilatation recedes. Accurate hæmostasis is necessary, as the general surgeon who is not familiar with children's surgery is apt to think that minute bleeding vessels are capillary oozing and forget that these small vessels represent large and important ones in the adult. The wound is then closed in layers and dressings applied. The child is returned to a heated bed, placed in charge of a special nurse, and turned over to the pediatrician for further feedings.

In operating upon infants for pyloric stenosis and finding no hypertrophy present, one should explore the subhepatic fossa for the presence of adhesions as the possible cause of the symptoms. Likewise, in delivering the stomach in these cases, if one encounters difficulty in mobilization, adhesions should be immediately suspected.

## CONGENITAL DUODENAL ADHESIONS

The prognosis should be somewhat guarded, as uncontrollable oozing may develop and a reformation of the adhesions may take place

The three deaths in this series, as shown by the following table, were late enough not to be considered operative deaths. They were all due to the reformation of adhesions, suspected in two cases and proven by autopsy in one. It is because of the liability of adhesions to reform that it is desirable to start early feedings in order to excite peristaltic waves. We have seen no cases with post-operative dilatation of the stomach from loss of nervous control

### *Table Case Reports*

- 1921 CASE I—Girl, white, aged eight weeks, weight, 6-10 pounds. Pre-operative diagnosis—Pyloric obstruction. Post-operative diagnosis—Duodenal adhesions. Result, died. Post-operative weight, 10-0 pounds. Cause of death—Reformation of adhesions. Remarks—Rapid gain in weight. Developed marked vomiting. Death two weeks after operation.
- 1925 CASE II—Girl, white, aged six weeks, weight, 6-4 pounds. Pre-operative diagnosis, Pylorospasm. Post-operative diagnosis—Duodenal adhesions. Result, died. Post-operative weight, 7-9 pounds. Cause of death—Reformation of adhesions. Remarks—Rapid gain, then gradual loss in weight, vomiting. Death sixteen days after operation. (Autopsy.)
- 1926 CASE III—Boy, white, aged eight weeks, weight, 8-10 pounds. Pre-operative diagnosis—Pyloric stenosis. Post-operative diagnosis—Duodenal adhesions. Result, recovered. Post-operative weight, 9-1 pounds. Remarks—Had slow convalescence. Gained weight slowly. Some vomiting continued for two weeks.
- 1930 CASE IV—Boy, white, aged twenty days, weight, 6-12 pounds. Pre-operative diagnosis—Pyloric stenosis and duodenal adhesions. Post-operative diagnosis—Duodenal adhesions. Result, died. Post-operative weight, 8-11 pounds. Cause of death—Reformation of adhesions (?). Remarks—Patient did nicely for three weeks, then vomiting recurred. Rapid gain, then loss in weight. Death one month after operation.
- 1930 CASE V—Girl, white, aged five days, weight, 7-12 pounds. Pre-operative diagnosis—Pyloric stenosis. Post-operative diagnosis—Duodenal adhesions. Result, recovered. Post-operative weight, 8-10 pounds. Remarks—No vomiting. Slight regurgitation. Rapid gain in weight. Bowels normal.
- 1931 CASE VI—Boy, white, aged four days, weight, 4-8 pounds. Pre-operative diagnosis—Duodenal adhesions. Post-operative diagnosis—Duodenal adhesions. Result, recovered. Post-operative weight, 5-12 pounds. Remarks—No vomiting. Slight regurgitation. Gain in weight. Bowels moved normally.

### CONCLUSIONS

Attention has been called to a very important clinical entity, to which the term "congenital duodenal adhesions" is applied inasmuch as the affection has a definite train of symptoms, and if borne in mind and prompt surgical treatment is instituted, many infants that are now dying from vomiting of undetermined origin may be saved.

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# STRANGULATION OF THE SIGMOID FLEXURE BY THE PEDICLE OF AN OVARIAN CYST

By FRANK C. BEALL, M.D.

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CASE REPORT—A woman, twenty-three years of age, was admitted to the W. I. Cook Memorial Hospital of Fort Worth, at 8 00 P.M., January 26, 1929. She had retired at midnight the night before feeling perfectly well and was awakened at about 7 00 A.M. by a severe colicky pain in the lower part of her abdomen. She soon became nauseated and vomited. The pains, with occasional nausea and vomiting, had persisted throughout the day. During the day she had been given four enemas. Her mother, who had given the enemas, stated that she had used about a quart of fluid at each time and that the enemas had been taken easily and without special discomfort by the patient. They were expelled easily. At no time was any fecal matter passed. With the last enema there was a slight tinge of blood. There was nothing of importance in the patient's past history. Her temperature on admission was 99.4 degrees, pulse 116, and respirations 24.

On palpation just above Poupart's ligament on the left side a firm, rounded, sausage-shaped mass about 5 inches in diameter could be felt. The mass was fixed and extended from the symphysis pubis upward and outward close to and parallel with Poupart's ligament. Its upper limit could not be made out, the mass disappearing in the loin above the anterior superior spine of the ilium. The left flank was dull on percussion. Pressure over the mass caused slight pain. The abdomen everywhere else was soft and free from tenderness.

On bimanual examination of the pelvis, two masses could be felt, the tense, fixed, sausage-shaped mass on the left side and, in the right side of the pelvis, a freely movable, elastic, spherical tumor the size of a grapefruit. The latter had all the characteristics of an ovarian cyst. The fundus of the uterus was fixed in semi-retroverted position somewhat to the left of the mid-line.

The patient was operated upon fourteen hours after the onset of symptoms. The abdomen contained about two quarts of dark brownish-black fluid with a peculiar musty odor. The mass on the left side proved to be an enormously distended sigmoid, the two limbs of which were approximated and bound tightly together by the pedicle of a left-sided ovarian cyst which was wrapped tightly one and one-half full turns around the two limbs of the bowel so that the cyst lay in the right side of the pelvis (Fig. 1). The sigmoid, about 16 inches in length and about 5 inches in diameter, was tightly distended. It was of a dark purple, almost black, color except the longitudinal bands which had a pale, pearly appearance with a faint purple tinge. A sero-sanguineous fluid was exuding from the whole surface of the bowel wall. The ovarian cyst was about 4½ inches in diameter and had a blue, cyanotic appearance. Its pedicle was ribbon-shaped, about 5 inches long and about ½ inch in width with a fanning out at its two ends. This cyst on later examination was filled with a bloody fluid and contained a small intracystic papilloma covered by a single layer of columnar epithelium. The body of the papilloma had a dense fibrous structure and did not seem to correspond to the ordinary papillomatous cyst.

The pedicle of the cyst was ligated and cut near its origin on the left side and the cyst removed. By slightly mobilizing the descending colon, all of the gangrenous part of the bowel could be drawn outside the abdomen. The upper part of the rectum and the descending colon were approximated by two rows of plain catgut sutures, a rubber-tube

## STRANGULATION OF SIGMOID FLEXURE

drain placed into the pelvis through the lower angle of the wound and the wound closed snugly around the tube and the exteriorized bowel.

Three days after the primary operation, the gangrenous bowel was cut away close to the skin with an electric cautery. On January 2, 1930, a clamp was applied to the spur between the two limbs of the bowel. This cut through on January 8. At this time an examination with a gloved finger showed a lot of induration in the bowel walls around the site where the clamp had cut through. After this induration had cleared up, it

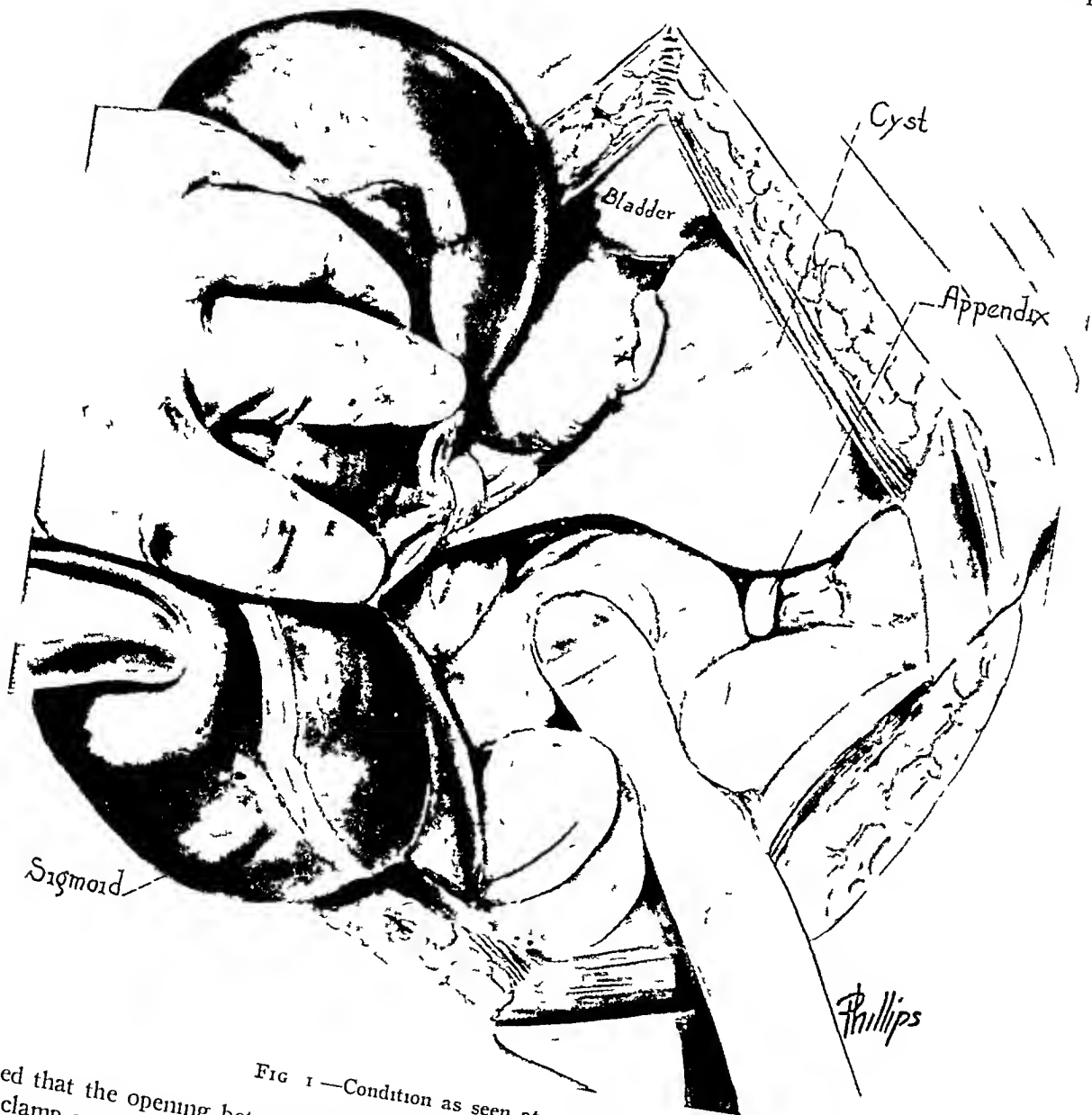


FIG 1—Condition as seen at operation

seemed that the opening between the two limbs of the colostomy might not be sufficient, so a clamp was applied to the spur a second time January 24. This clamp came away January 30. February 7 with local anaesthesia and gas, after freeing the intestine to a certain extent, the colostomy was closed with a Connell suture of chromic catgut in an end-to-end fashion and the superficial tissues approximated over a soft rubber drain by through-and-through sutures of silkworm gut. There was no faecal drainage. The patient's bowels moved spontaneously eight days later and have moved regularly since—usually twice a day. She was discharged from the hospital ambulant, February 23, 1930.

# THE TREATMENT OF ILEUS

AS INDICATED BY CLINICAL EXPERIENCE AND EXPERIMENTAL STUDIES\*

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FROM THE DEPARTMENT OF SURGERY OF THE UNIVERSITY OF ROCHESTER

THE treatment of acute intestinal obstruction is a challenge to the judgment and technical skill of any surgeon. The high mortality from this condition has stimulated intensive experimental researches over the last thirty years. It is my intention to briefly review the knowledge that has been gained from these studies, and to indicate any practical value we have found by the actual application to the treatment of acute intestinal obstruction in our clinic.

One of the most important advances is the recognition of at least three distinct types of dynamic obstruction. Much confusion can be avoided by taking cognizance of the differences between simple occlusions without damage to the blood supply or tissues, the rapid necrosis of strangulations, and possible combinations of these two states. The first of these forms is well illustrated by pyloric stenosis, the second by strangulated hernia, and the third, by adhesions obstructing a small bowel loop which cannot be emptied because of torsion or some other factor. We will return to this discussion later.

It has been found that the normal small intestinal mucosa provides an adequate defense against the absorption of any of the more toxic colloids. The simpler molecules of low molecular weight readily pass the barrier. There is thus a selective absorption which operates continuously to protect us from the many poison products of normal digestion. The poisons are either detoxified in passage through the bowel wall or are hurried along the intestinal canal and rendered inert by digestive enzymes. The normal mucosa is also impenetrable to introduced poisons of high molecular structure<sup>1, 2, 3</sup>. The normal bowel below an obstruction does not absorb the poisons from the obstructed loops when the obstruction is released. The normal small bowel contains small numbers of bacteria even in the higher segments<sup>4, 5</sup>. The continued loss of the normal secretions from the higher segments may lead to a very serious condition<sup>6, 7</sup>. The total loss of these secretions by vomiting or through a fistula for any length of time brings about a picture which closely parallels a high obstruction at the same level<sup>8</sup>.

When a small bowel loop is obstructed, there is an upset in the whole neuromuscular mechanism at least down to the obstructed point. On the motor side, peristaltic waves, originating above, attempt to pass the contents beyond the obstruction. Their ineffectiveness leads to a disturbance of the normal gradient with reversed peristalsis and vomiting<sup>9</sup>. If vomiting keeps

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\* Read before the New York Academy of Medicine, December 4, 1931

the involved bowel empty, the simple type of obstruction similar to pyloric stenosis is produced. If by kinking or twisting the involved bowel segments are prevented from draining, another sequence of events ensues, producing the third type of obstruction, a mixture of obstruction and strangulation. Obstructed undrained intestinal loops furnish ideal conditions for bacterial growth. *Bacillus welchii*, among other bacteria, is present in most cases and increases enormously in numbers<sup>10, 11</sup>. There is no escape for the trapped secretions. The absorption rate from the involved area is less than under normal conditions<sup>12, 13</sup>. In the higher segments accumulation of secretions is by no means slow. The intra-intestinal pressure rises quickly<sup>14</sup>. The bacteria cause putrefaction with liberation of gas, which helps increase the distention. The fluid content of the loops becomes very foul and toxic if absorbed. The toxic properties as a rule take more than thirty-six hours to develop, after thirty-six hours the contents become very toxic<sup>15</sup>. If the distention inside the lumen increases beyond a certain point, the capillary circulation is stopped. Ischæmia and necrosis result, especially in the capillary distribution along the anti-mesenteric border<sup>16</sup>. The shorter the trapped segment, the more dangerous is this intra-intestinal pressure<sup>17</sup>. The secretion rate in the upper segments is considerably greater than that in the lower small bowel. Consequently, a trapped high loop develops pressure more quickly than a similar low one<sup>14</sup>.

It is generally conceded that there is a toxæmia with strangulation. If the circulation is shut off, the picture is more acute and death is more rapid<sup>17</sup>. The shorter is the strangulated segment, the more rapidly fatal the outcome<sup>17</sup>. Infectious and toxic intestinal wall materials in strangulation go directly into lymph channels or into the general blood-stream<sup>18</sup>.

It has been long debated as to whether there is a toxæmia in the simple high obstructions. The evidence seems to be increasing that toxæmia has little part in this picture. There is, on the other hand, loss of fluids and salts, by constant vomiting. Death appears to be from dehydration, demineralization and starvation<sup>19, 20</sup>. Animals can be kept alive and in good condition for long periods by reintroducing the vomited material through an enterostomy below the obstruction<sup>21</sup>. The blood-chemistry change in animals with obstruction at a definite level is decidedly different from that in animals obstructed at the same level but maintained in salt balance<sup>22</sup>. There is a striking similarity in the clinical picture, blood-chemical changes and life expectancy in animals with simple high obstruction and those with complete fistula at the same level. The syndrome is due to a deficiency of essential secretions through loss from the upper gastro-intestinal tract<sup>8</sup>.

From a practical standpoint, however, it is the part of wisdom to regard every obstruction of the intestine as a potential strangulation with impending toxæmia until otherwise demonstrated. This is especially necessary when there is a chance for failure of drainage in sagging loops. Here, the opportunity for increased intra-enteric pressure makes it possible to develop necrosis and consequent toxæmia.



The nature of the toxins in intestinal obstruction has been the subject of much work. The present-day opinion is that there is no specific toxin in obstructed gut fluid that is the cause of death<sup>23</sup>. There are many poisons present as the products of normal digestion or putrefaction which may be effective. If all food and normal secretions such as bile, pancreatic and gastric juice be excluded from a loop, the secretion then formed in the lumen is not toxic either on intravenous or intraperitoneal injection<sup>24</sup>. The presence of bacteria is essential for the formation of toxins<sup>24, 25</sup>. When bacteria are excluded, even autolysis of an involved segment *in vitro* or *in vivo* will not elaborate sufficient toxin to kill the animals<sup>25, 26</sup>. No specific antibodies are produced by repeated intravenous injections of closed loop fluid<sup>27</sup>. This would indicate that the toxic principles are probably not of protein nature. Every known soluble complete protein may act at least to some degree as an antigen. The entire mass of cleavage products of a protein are not antigenic<sup>28</sup>. There is no increase in immunity or tolerance to intestinal obstruction after recovery from a previous obstruction<sup>29</sup>. As the toxin is not specific in nature, the use of Welch bacillus antitoxin in therapy is not of value<sup>30</sup>. The toxins are quickly formed in most closed loops<sup>31</sup>. Large amounts of closed loop fluid can be introduced into the normal intestine without effect<sup>1, 2, 3</sup>. There is no evidence that toxins circulate in the blood of animals or patients dying of intestinal obstruction. The blood of such animals can be transfused into normal animals without causing any symptoms<sup>31</sup>. It would seem that the toxins are rapidly fixed by the tissues and only minimal quantities ever circulate.

The evidence for the pathway of absorption of the toxins is rather indefinite. Minute quantities have been demonstrated in the blood in the agonal stages of the condition<sup>32</sup>. The mucosa theory has been difficult to prove by experiment<sup>1</sup>. Many investigators agree that there is no absorption except through an injured mucosa. This they consider more essential than the formation of the toxin<sup>6, 17</sup>. The importance of increased intra-intestinal pressure is coming more and more to be recognized. This leads to stasis, ischaemia, and focal necrosis exposing the vascular bed<sup>14</sup>. Toxins can be recovered under these circumstances from the thoracic duct<sup>33</sup>. It is known that the vascular bed of the peritoneum readily absorbs toxins of high molecular structure<sup>34</sup>. The fissures and gangrenous patches allow the toxic material to come in contact with the visceral peritoneum, offering thus another method of absorption without demonstrable peritonitis<sup>14, 35</sup>. Emptying a distended loop full of toxic material even by the slightest manipulation causes damage to the friable mucosa, haemorrhage, and absorption of toxin. If the loops are extraperitoneal in position, damage to them causes little effect except development of a fistula, if intraperitoneal, it quickly kills<sup>35</sup>. By preventing distention in a majority of instances toxæmia does not occur<sup>24</sup>. If pressure is taken off by aspiration of the loop, no toxicity develops and the level of the non-protein nitrogen does not increase in the blood. When normal circulation to the obstructed loop is maintained, toxins

are not taken up, or, at least, not faster than they can be handled<sup>23</sup> Mounting pressure within the bowel is very important in the absorption of toxins but delays the circulation and thus slows their dissemination<sup>36</sup> Pilocarpine, even in small doses, hastens the fatal termination by increasing the fluid distention in experimental animals with small bowel obstruction<sup>37</sup> Symptoms of intoxication which follow release of obstructions are due to damaging of the occluded loop and absorption there, and not from the healthy bowel below<sup>35, 38</sup> If one strips the small intestine of a normal animal from above down the carotid pressure sinks but recovers again and in forty-five minutes returns to its normal When the same thing is done after an ileus of twenty-four hours' duration, the blood-pressure sinks lower than normal and shows little tendency to return A proportion of these animals quickly die<sup>39</sup> There is ample proof that death in intestinal obstruction is not due to a septicæmia or to a peritonitis Much experimental work has disproved these theories formerly held The occurrence of either septicæmia or peritonitis must be regarded as a complication

Simple occlusion without damage to the blood supply or tissues such as in pyloric stenosis, if long enough continued, leads to dehydration, alkalosis, and starvation The dehydration and alkalosis are due to the loss of water and acid through vomiting If the loss of acid from the body is so rapid that the balance in the blood cannot be maintained, alkalosis becomes inevitable<sup>40</sup> Laboratory tests on the blood will show that there is progressive diminution of the chlorides, a corresponding rise in non-protein nitrogen, and a high carbon-dioxide combining power<sup>7</sup> Administration of sodium chloride prolongs the life<sup>7</sup> As long as the chlorides can be kept near the normal level, the other changes in the blood do not occur<sup>41</sup> Other chloride salts cannot take the place of sodium chloride<sup>42</sup> Water alone is not effective in therapy<sup>43</sup> The importance in supplying sodium chloride is in replacing the sodium base Without this base fluid is lost as fast as it is given<sup>44</sup>

The problem of an early simple high obstruction, then, becomes one of maintaining the normal sodium-chloride level of the blood If there is no dehydration and no alkalosis in consequence, it is often possible to carry patients for many days, even though the obstruction is not relieved The general condition is such that it is then possible to attack the obstruction under favorable conditions Toxæmia is in the background or does not exist in these early simple obstructions

Strangulation, on the other hand, is an entirely different problem Toxæmia is the paramount issue in this form of obstruction Dehydration, alkalosis, and starvation are of little significance, if they exist at all Many times there is no evidence of their existence although the patient is overwhelmed by toxins A laboratory test on the blood will show a high non-protein nitrogen, although it is best not to wait for it The blood chlorides and carbon-dioxide combining power of the blood will show little change Administration of sodium chloride has no effect in this form of obstruction The problem is to remove as rapidly as possible the offending segment which

is giving rise to the toxæmia. The danger of delay is that of an overwhelming absorption of toxins, or impending rupture with rapidly fatal peritonitis. If once the toxin is widely disseminated we have no remedy that is of any value.

Long-continued undrained obstructions form a third type of intestinal ileus which combines the features of both simple and strangulation obstructions. The long-neglected loops become heavy with a very foul secretion. Distention takes place until at times the small bowel becomes enormous. Capillary engorgement and stasis of the blood supply occurs. Focal necroses develop, especially along the anti-mesenteric border. The capillary loops are exposed to the toxic material in the lumen, selective absorption is no longer effective. A toxæmia develops rapidly. Focal patches of gangrene allow peritoneal absorption of toxins as well as that through the capillary bed, or an actual rupture may occur, causing a fatal peritonitis. In this type of obstruction, dehydration, alkalosis and toxæmia are all prominent features. The problem is to supply sodium chloride and water and to remove the obstruction with as little manipulative disturbance as is consistent. This type of obstruction calls for the most careful judgment on the part of the surgeon and the patient's life depends on the wisdom of his decisions. It is most frequently seen in the forty-eight to seventy-two hours after the onset of an obstruction. If this critical period is passed without toxæmia developing, it is an indication that the loops are being effectively drained through vomiting.

The clinical cases here presented will include ileus in all its forms as related to the small intestine only, and excluding pyloric and duodenal obstruction. Paralytic ileus, partial obstruction and obstruction to the large bowel will not be considered. The operations in this series were performed by fourteen different surgeons, members of the attending and resident staff.

When a patient enters the hospital with the symptoms of acute intestinal obstruction or develops them in the hospital, we make an effort to decide whether we are dealing with a strangulation, a simple obstruction or a combination of the two. It is not always possible to decide, but in such instance we proceed on the assumption that it is the worst form. We make our diagnosis on the history and clinical examination and do not depend on laboratory studies except for localization by the Röntgen-ray.

In the simple high obstructions our plan is to restore fluids and salt balance. There is no need for haste in this type of obstruction as exemplified by pyloric stenosis. We depend a great deal on the blood-chemistry reports and guide our treatment accordingly. When the balance is restored we relieve the obstruction. The group of cases most nearly representing the simple obstruction in this report is that of obstruction at the site of a gastroenterostomy. When the operation has been done years before the diagnosis is not so difficult, but on a newly operated individual in whom some accident has occurred at the gastroenterostomy opening, it is diagnosed with great reluctance. There have been seven of these cases in our series with two

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deaths, a mortality of 28.5 per cent. There should be no mortality in this group. The fatalities were due to too late diagnosis in one patient following a resection for cancer of the stomach, and to a technical error with abscess formation in the lesser sac in the second. Enteroenterostomy usually relieves these patients promptly.

### *Simple High Obstruction*

#### *(Excluding Pyloric and Duodenal Obstruction)*

No 6459, male, aged fifty-one years. Type of obstruction—Posterior gastroenterostomy with kink of distal jejunal loop. Time since onset—Recent operation. Two weeks after operation. General condition—Poor from prolonged vomiting. Anæsthesia and operation—Gas and oxygen, ether. Enteroenterostomy. Result—Well.

No 10,502, male, aged sixty-nine years. Type of obstruction—Posterior gastroenterostomy. Adhesions about Treitz's fossa. Time since onset—Old operation, eight years. Gradual onset two weeks. General condition—Mitral lesion. Arteriosclerosis. Bladder obstruction. Non-protein nitrogen, 57. Anæsthesia and operation—Scopolamine-morphine-local. Enteroenterostomy. Result—Well. Remarks—Enormous distention of duodenum.

No 20,627, male, aged forty-five years. Type of obstruction—Posterior gastroenterostomy. Adhesions about Treitz's fossa. Time since onset—Old operation. Six to eight hours only. General condition—Good. Anæsthesia and operation—Gas and oxygen. Release of adhesions. Result—Well.

No 44,904, female, aged fifty-four years. Type of obstruction—Posterior gastroenterostomy. Retrograde incarceration. Time since onset—Recent operation, gradual for sixteen days. General condition—Fair. Anæsthesia and operation—Avertin. Enteroenterostomy. Result—Well.

No 47,737, female, aged thirty-six years. Type of obstruction—Posterior gastroenterostomy. Adhesions about Treitz's fossa. Time since onset—Old operation. Gradual for seven days. General condition—Fair. Anæsthesia and operation—Avertin, gas and oxygen. Release adhesions. Enteroenterostomy. Result—Well.

No 18,151, male, aged thirty-eight years. Type of obstruction—Pólya type anastomosis. Obstruction from abscess. Time since onset—Old operation. Posterior gastroenterostomy, gradual obstruction complete. General condition—Poor. Anæsthesia and operation—Gas and oxygen, ether. Enteroenterostomy. Result—Died. Remarks—Abscess lesser sac.

No 38,174, female, aged fifty years. Type of obstruction—Posterior gastroenterostomy with kink of distal jejunal loop. Time since onset—Recent operation. Five to ten days post-operative. General condition—Resected cancer of stomach. Anæsthesia and operation—Gas and oxygen. Enteroenterostomy. Result—Died.

In strangulations the administration of salt solution will not prove as valuable as in the simple obstructions. Here the ideal is to get the strangulated segment outside the peritoneal cavity, restoring the normal intestinal current as soon as possible. We usually do a direct end-to-end anastomosis when circumstances permit. In very desperate cases we have tried enteroenterostomy, the Mikulicz type of removal, or enterostomy alone.

There were twenty-two cases of strangulation in which there was massive necrosis of a segment of bowel. These consisted in three instances of gangrenous intussusceptions. In one, an adult with intussusception originating beside a polyp in the lower ileum, resection and end-to-end anastomosis produced a cure. Two died, one, a six months' baby brought in after three

days, too late for cure, the other, a seven months' baby who, after resection, was progressing favorably but succumbed to an accidental boric-acid poisoning. Four cases of mesenteric thrombosis all died when gangrene was present. One patient had a resection and end-to-end anastomosis. He was a seventy-year-old man who was in critical condition after two days of obstruction and there were thirty inches of necrotic ileum with a rupture of the appendix. Another man of fifty-five had endocarditis, infarction in various organs, and patchy necroses of the lower two feet of terminal ileum. An ileocolostomy was done to sidetrack the involved bowel, but the non-protein nitrogen of the blood was eighty-eight at the time of operation and he died from continued progress of his disease. A fifty-two-year-old man had his obstruction for four days and only an enterostomy was done which did not relieve him. The fourth patient was a seventy-five-year-old woman who had had obstruction for several days. She died six hours after entry without operation as she was in too critical condition to even consider it. Post-mortem examination showed mesenteric thrombosis. There were four cases of volvulus with massive gangrene, two about old adhesions, and two about Meckel's diverticuli. Three of these patients died. The two with volvulus about adhesions were too late for surgical help—coming in after three days and six days of obstruction respectively. In both instances the necrotic bowel was brought outside in a Mikulicz procedure without benefit. In one of the Meckel's diverticulum cases resection with end-to-end anastomosis was successful, in the other, there was, unfortunately, a second obstruction at the anastomosis. It was recognized too late. This death must be regarded as a surgical failure. Four cases of strangulated inguinal hernia had successful resections and anastomoses with cure. There were four cases of strangulated femoral hernia. Three were resected and anastomosed with cure, the fourth died after similar treatment. This death cannot be charged to surgery as the woman arrived after five days of obstruction with perforation, and a blood non-protein nitrogen of 75, too late for help. She had her operation under local anæsthesia but also had a complicating pneumonia post-operatively. In three cases of ventral hernia two resections were successful but the third patient died after operation in diabetic coma, an unavoidable death.

The two cases of partial necrosis were handled by inverting the gangrenous patches and reinforcing the involved area. Both recovered without incident.

*Strangulation—Massive Necrosis*

No 7960, female, aged seven months. Type of obstruction—Intussusception. Time since onset—Twelve hours. General condition—Poor. Anæsthesia—Drop ether. Operation—Resection, end-to-end anastomosis. Result—Died. Remarks—Boric-acid poisoning.

No 42,217, male, aged six months. Type of obstruction—Intussusception. Time since onset—Three days. General condition—Very poor. Anæsthesia—Drop ether. Operation—Resection, end-to-end anastomosis. Result—Died. Remarks—Too late.

No 43,395, male, aged fifty-five years. Type of obstruction—Intussusception, polyp. Time since onset—Two days. General condition—Very ill. Anæsthesia—Gas and

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oxygen Operation—Resection end-to-end anastomosis Result—Well Remarks—Gangrene six inches ileum

No 14,301, male, aged fifty-two years Type of obstruction—Mesenteric thrombosis Time since onset—Four days General condition—Fair, non-protein nitrogen, 60 Anæsthesia—Local Operation—Enterostomy Result—Died Remarks—Enterostomy, spinal, no avail

No 20,791, male, aged fifty-five years Type of obstruction—Mesenteric thrombosis Time since onset—Gradual, time? General condition—Endocarditis, non-protein nitrogen, 88 Infarction of spleen Anæsthesia—Gas and oxygen Operation—Ileocolostomy Result—Died Remarks—Patchy gangrene twenty-four inches ileum, too late

No 23,108, female, aged seventy-five years Type of obstruction—Mesenteric thrombosis Time since onset—Several days General condition—Prostrated, œdema, bad heart, dyspnœa No operation Result—Died Remarks—Died six hours after entry

No 33,844, male, aged seventy years Type of obstruction—Mesenteric thrombosis Time since onset—Two days General condition—Critical, auricular fibrill infarction of liver Anæsthesia—Spinal Operation—Resection, end-to-end anastomosis Result—Died Remarks—Thirty inches gangrene ileum, too late

No 4152, female, aged fourteen years Type of obstruction—Volvulus, about adhesions Time since onset—Three days General condition—Very bad, peritonitis Anæsthesia—Gas and oxygen, ether Operation—Mikulicz first stage Result—Died Remarks—No chance for surgery, thirty-two inches gangrene ileum

No 51,485, female, aged seventy-seven years Type of obstruction—Volvulus about adhesions Time since onset—Six days General condition—Obese, peritonitis, non-protein nitrogen, 75 Anæsthesia—Ether Operation—Mikulicz first stage Result—Died Remarks—No chance for surgery—twenty-four inches gangrene

No 23,574, male, aged thirty-three years Type of obstruction—Volvulus about Meckel's diverticulum Time since onset—Twenty-four hours General condition—Poor, non-protein nitrogen, 85 Anæsthesia—Gas and oxygen, ether Operation—Resection, end-to-end anastomosis Result—Died Remarks—Second obstruction at anastomosis

No 7055, male, aged eleven years Type of obstruction—Volvulus about Meckel's diverticulum Time since onset—Nine hours General condition—Fair Anæsthesia—Ether Operation—Resection, end-to-end anastomosis Result—Well

No 8411, female, aged fifty-one years Type of obstruction—Strangulated ventral hernia Time since onset—Nine and a half hours General condition—Obese, severe diabetes, mitral insufficiency Anæsthesia—Gas and oxygen, local Operation—Enterenterostomy above damaged loop Result—Died Remarks—Diabetic coma, blood sugar, 455

No 14,382, female, aged thirty-six years Type of obstruction—Strangulated ventral herma Time since onset—Twelve to sixteen hours General condition—Obese Anæsthesia—Gas and oxygen, drop ether Operation—Resection, end-to-end anastomosis Result—Well Remarks—Twenty-four inches gangrene of jejunum

No 33,828, female, aged forty-nine years Type of obstruction—Strangulated ventral hernia Time since onset—Nine hours General condition—Extreme obesity, hypertension, asthma Anæsthesia—Spinal Operation—Resection, end-to-end anastomosis Result—Well Remarks—Six inches gangrene jejunum

No 6739, male, aged forty-three years Type of obstruction—Strangulated inguinal hernia Time since onset—Five hours General condition—Active pulmonary tuberculosis Anæsthesia—Local, gas and oxygen Operation—Resection, end-to-end anastomosis Result—Well Remarks—Eighteen inches gangrenous ileum

No 14,416, male, aged seventy-seven years Type of obstruction—Strangulated inguinal hernia Time since onset—Sixteen to eighteen hours General condition—Over 200 pounds, cyanosed, fibrillating Anæsthesia—Local Operation—Resection end-to-end anastomosis Result—Well Remarks—Eight to ten inches gangrenous ileum

No 30,050, male, aged forty-nine years Type of obstruction—Strangulated inguinal hernia Time since onset—Twenty-four hours General condition—Fair Anæsthesia—Ether, chloroform Operation—Resection, end-to-end anastomosis Result—Well Remarks—Eighteen inches gangrenous ileum

No 31,394, male, aged twenty-three years Type of obstruction—Strangulated inguinal hernia, reduced *en masse* Time since onset—Forty-eight hours General condition—Good Anæsthesia—Gas and oxygen, ether Operation—Resection, end-to-end anastomosis Result—Well Remarks—Ten inches gangrenous ileum

No 12,646, female, aged forty years Type of obstruction—Strangulated femoral hernia Time since onset—Ten hours General condition—Good Anæsthesia—Gas and oxygen, ether Operation—Resection, end-to-end anastomosis Result—Well Remarks—Seven and a half inches gangrenous ileum

No 16,836, male, aged sixty years Type of obstruction—Strangulated femoral hernia Time since onset—Two to three hours General condition—Bad heart, asthma Anæsthesia—Local Resection, lateral anastomosis Result—Well Remarks—Nine inches gangrenous ileum

No 24,613, female, aged forty-eight years Type of obstruction—Strangulated femoral hernia Time since onset—Five days General condition—Bad, peritonitis Anæsthesia—Local Operation—Resection, end-to-end anastomosis Result—Died Remarks—Six inches gangrenous ileum, died pneumonia

No 30,659, female, aged forty-six years Type of obstruction—Strangulated femoral hernia Time since onset—Four days General condition—Fair Anæsthesia—Gas and oxygen, ether Operation—Resection, end-to-end anastomosis Result—Well Remarks—Eight inches gangrenous ileum

#### *Focal Necrosis*

No 34,720, male, aged one month Type of obstruction—Strangulated inguinal hernia Time since onset—Twenty-four hours General condition—Poor, malnutrition Anæsthesia—Ether Operation—Infolding necrotic area, release obstruction, repair Result—Well

No 49,204, female, aged forty-five years Type of obstruction—Strangulated femoral hernia Time since onset—Two and a half hours General condition—Good Anæsthesia—Local Operation—Release obstruction, infolding necrotic area Result—Well

The largest number of intestinal obstructions combine the features of obstruction and strangulation And it is to this type of obstruction that the facts determined by experimentation are most applicable In no other kind of surgery, also, is there so much opportunity for the display of surgical judgment In many instances the margin of safety is so small that the slightest mistake will tip the balance the wrong way The essence of surgical success consists in doing as little as is necessary to relieve the obstruction Among the reasons for early operation may be urged the following There is less shock and toxæmia in handling the less dilated loops There is less distention and the loops are not so much in the way There is less danger of an obstructed circulation There is less danger of rupture from manipulation There is less dehydration and loss of salts The patient is in better shape to more safely stand the operation The one thing a surgeon must constantly guard against is the lure to go on doing just a little more in a complicated case Each case is a problem in itself and no set rules can be applied The salt and water balance should be restored and the obstruction released or side-tracked as may seem expedient The operation should be

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performed as quickly as is consistent with good surgery. The obstructed loops should be handled as little as possible. There is good evidence that this is a dangerous procedure. For this reason it is safer to seek out the collapsed loops and trace them upwards toward the obstruction rather than working from the obstructed loops downwards as is usually taught. When once the distention has been relieved in the involved bowel we think that surgery has accomplished all that is possible. The rest of the treatment is supportive with the hope that too great a toxæmia has not already been established. We do not fear absorption of the retained bowel secretions when the tension has been released. We think that stripping the bowel is

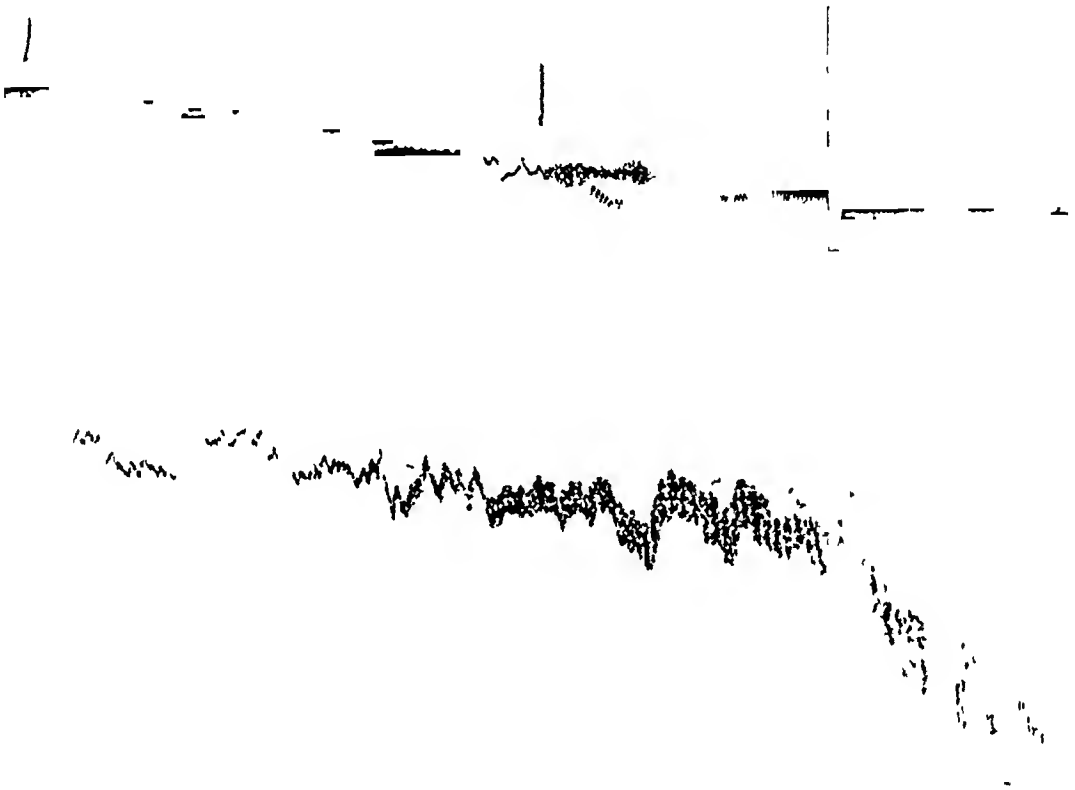


FIG 1 —When the contents of the obstructed bowel are emptied by "stripping" the bowel between the fingers, there is a marked fall in blood pressure in experimental animals (Illustration reproduced from Lawen's article *Zentralbl f Chir*, vol liv, p 1037, 1927)

a very dangerous procedure and have evidence that it acts the same in human cases as it does in animals (Fig 1)

No 27,172 H D, aged thirty-eight years, was admitted to the Strong Memorial Hospital, August 17, 1929, following an automobile accident in which he received an injury to the head. He struck his abdomen on the steering wheel. On admission the only finding was a laceration of the scalp. The day following, there was soreness of the neck and abdominal muscles and he felt quite ill. Two days after the accident, he complained of having a few cramps in the upper abdomen and of distention. He was relieved by an enema. Distention and cramps became worse and he had difficulty in voiding.

Examination showed generalized abdominal tenderness, not very severe, also moderate distention with no evidence of shifting dullness. There had been two normal bowel movements on this day. The white blood count was 15,000. It was decided to



explore the abdomen, because his pulse was gradually rising. Exploration was done on August 20. Turbid fluid was found in the abdomen. The bowel was greatly distended. In the right lower quadrant, there was a mass which turned out to be strangulated terminal ileum, the bowel having passed through a small tear in the mesentery. The appendix, which was caught in this strangulation, was gangrenous. The appendix was removed. A tube was placed in the intestine and the dilated bowel was emptied of its contents. The patient was greatly shocked by this procedure. His blood-pressure

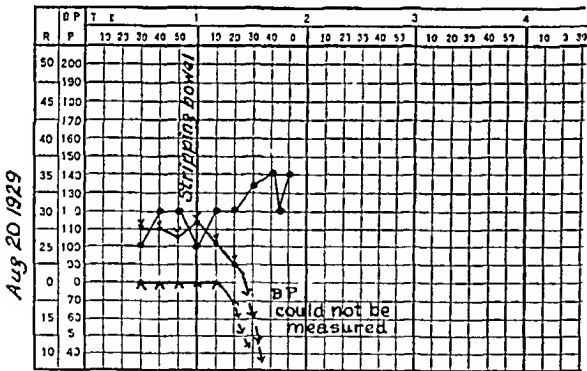
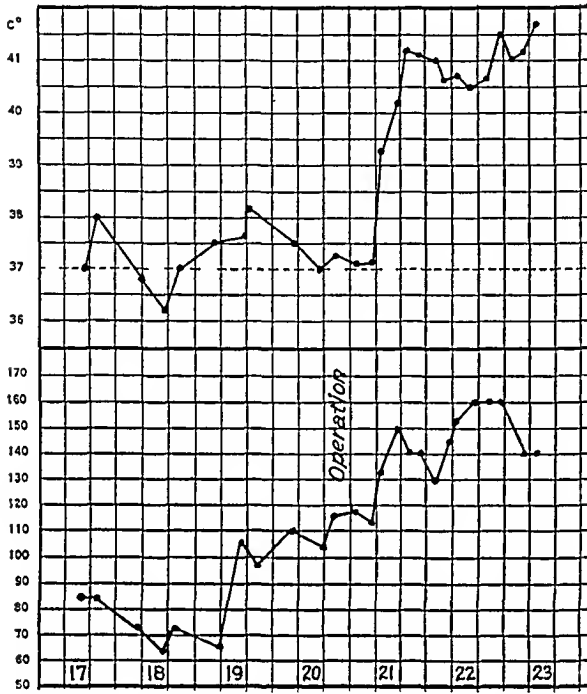


FIG 2—The same effect is noted in the human subject when the bowel is similarly 'stripped'

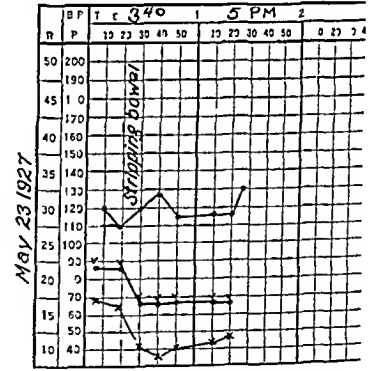
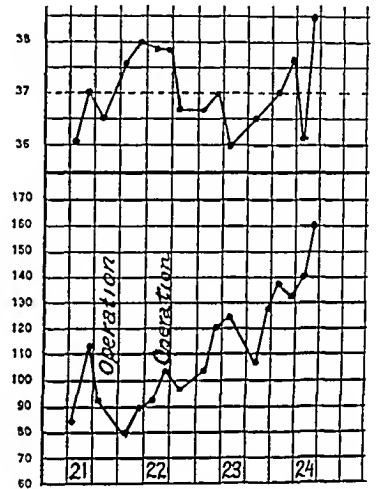


FIG 3—A second instance of the same reaction

dropped until it could no longer be obtained. Following stimulation and intravenous treatment, by the next morning he had revived somewhat. His temperature rose steadily, and also the pulse rate. Saline was administered in large quantities but blood chlorides dropped to 400. The blood non-protein nitrogen rose to 68 the day following operation and the blood-pressure remained low. In spite of the fact that he was given 5,000 cubic centimetres saline daily, the blood chlorides dropped to 316 and the blood non-protein nitrogen rose to 117. On August 23, he became comatose and died (Fig 2).

No 7150, J C, a sixty-one-year-old man, was admitted to the Strong Memorial Hospital, May 21, 1927. He complained of distention and vomiting of four days' duration

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The patient had a right inguinal hernia which came down four days before admission and could not be replaced. There was very severe pain about one and a half days later and the hernia had to be reduced about that time. The pain disappeared but vomiting persisted and became faecal in type. He appeared extremely ill and toxic. His abdomen was distended. There was visible peristalsis. The hernia was not down. The ring was dilated but otherwise there were no positive findings. His blood non-protein nitrogen was 85 and blood chlorides were 395. He was taken to the operating room one hour after admission, having had a saline infusion. An enterostomy was done under local anaesthesia. He was relieved and appeared considerably improved for about twelve hours. The following day he appeared to be worse and his blood non-protein nitrogen was 127 and blood chlorides were 372. A second operation was performed, at which time the obstructed small intestine was opened and the contents emptied through a tube. Although there was marked local improvement in the color and tone of the bowel, the blood-pressure dropped following this procedure and the condition became decidedly more critical. He continued to grow worse and on the day following he died. The final non-protein nitrogen reading was 182 (Fig 3)

We believe that simple enterostomy occasionally tides over a crisis until the real problem can be handled, but at best it is only a makeshift operation. In general, the more perfectly an enterostomy functions the worse it is for the patient. When there is a complicating peritonitis present, we are convinced that enterostomy has been a bad operation in our hands. There is resolution quickly in the region of the enterostomy so that the tube does not stay in place long. The opening becomes larger and a fistula develops, which is as bad itself as a high obstruction in that there is no control over the loss of essential secretions. The skin becomes excoriated. Local abscess may develop. In several instances resection with anastomosis has been necessary.

No 18,198, J B, a man of forty-two years, was admitted to the Rochester Municipal Hospital, September 20, 1928. He was taken to the operating room, where a ruptured appendix was removed. There was generalized peritonitis present at the time. Following the operation he was very distended, so much so that there was considerable respiratory embarrassment. A duodenal tube was inserted and left in place, but no improvement having occurred in three days an enterostomy was done under local anaesthesia. The blood non-protein nitrogen was 43 and chlorides were 473, with carbon-dioxide combining power of 55 per cent. Twelve days following this a pelvic abscess was drained. During all this time there was distention, which by October became quite severe. At the drainage of the abscess, it was noted that the small bowel was all bound in a mass of adhesions which apparently accounted for the distention. Three weeks following this, the infection having subsided, the small bowel during all this time having drained through an enterostomy, operation was performed for release of adhesions. This was done under gas-oxygen anaesthesia. The patient continued to go downhill, although his bowel now passed material, and it was decided that it was due mainly to the fistula at the old enterostomy site. Through this place the patient lost repeatedly tremendous amounts of fluid which excoriated his whole abdominal wall. Nevertheless, on November 12, 1928, the fistula in the jejunum was resected, and an end-to-end anastomosis was performed. All incisions healed up nicely and he gained both in strength and weight, so that three weeks following closure of the jejunum he was allowed to be up. He was discharged to the surgical Out-Patient Department and warned against eating heavy meals or anything with a large residue. This was carefully explained to the patient and a smooth diet given to him.

Nine days after discharge from the hospital, he took a very heavy meal and was suddenly seized with acute abdominal cramps. He entered the hospital again on Decem-

ber 19, 1928, where it was evident that there was another acute obstruction. The blood non-protein nitrogen was 41.5 and chlorides were 480. At operation two tremendously dilated loops of bowel were found twisted around adhesions at the site of the old enterostomy. The volvulus was untwisted, the adhesions were excised and his recovery was uneventful. On June 26, 1931, he had a repair of a ventral hernia done. He has had no further trouble with intestinal obstruction since the operation in 1928. On November 21, 1931, he reported to the follow-up clinic. There were no complaints.

We now get relief in these cases by an inlying duodenal tube kept in place for gravity drainage for periods of twelve to eighteen hours. And we do not hesitate to attack the real seat of obstruction in the pelvis, even though it be necessary to open an infected area to do it. The collapsed ileal loops are traced down and the adhesions released.

The choice of anæsthesia is very important. The surgeon now has a considerable number of anæsthetics at his disposal. Spinal anæsthesia, nitrous oxide and oxygen supplemented by local anæsthesia, ethylene and local anæsthesia, all have their places and contraindications. Ether and chloroform are to be avoided if possible. The basal anæsthetics, avertin and sodium amytal, when reinforced by nitrous oxide, may also find a place.

We have had seventy-four patients who had obstructions which could be classed in this group. There were thirteen obstructed inguinal hernias with two deaths. One patient died from a *Streptococcus viridans* septicæmia, and the other had a paralytic ileus following reduction of his two-day obstructed hernia by an outside physician. In the hospital he had what we now consider a poor surgical procedure—stripping the bowel of its contents. Five obstructed femoral hernias were released and recovered without incident. In six cases of ventral hernia there were three deaths, a type of hernia which occurs in bad-risk patients even when uncomplicated by obstruction.

One extremely obese woman of seventy-five years had paralytic ileus, following release of her obstruction, necessitating secondary wound closure on the thirteenth day. At autopsy there was an abscess of the left lung, bronchopneumonia, and chronic myocarditis. A sixty-nine-year-old man entered with an obstructed hernia through an old appendix scar. It was sixty hours since the obstruction had occurred and he died in the operating room following a simple release of the obstruction under local anæsthesia. This patient was overwhelmed by his toxæmia and nothing could have saved him. The third fatality occurred in a 225-pound, fifty-three-year-old woman who had an obstructed ventral hernia the size of a football. She had been obstructed for twenty-four hours but refused operation for another twelve hours. She then asked for operation but it was too late to be successful. An internal hernia into the lesser peritoneal sac in a three-day-old baby was freed and the patient made an uninterrupted recovery. In three patients with herniation through tears in the mesentery there were two deaths. One patient entered the hospital eleven days after the onset of his trouble and although the bowel was released and appeared viable, he became worse and died with a general peritonitis.

The second fatality was in a man who had a tear through the mesentery in an accident. The hugely distended bowel was emptied of its contents through a Paul's tube. He never recovered from the shock of this procedure. In the third case a tremendously dilated loop could not be delivered through the rent but the operator performed a lateral anastomosis between the distended and collapsed loops nearest to the torn mesentery. Recovery was uninterrupted. The segment was resected successfully.

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at a later operation. In one case of obstruction due to the passage of a large gall-stone which had ulcerated through, too much surgery was necessary to complete the operation. The patient was unable to stand it in her precarious condition. Three cases of intussusception were reduced and recovered without complication. One patient with apparent mesenteric thrombosis, whose symptoms indicated an extension upward from a pelvic peritonitis, made a recovery after simple enterostomy. The bowel was a Concord grape color but it must have been viable because it resumed its function after a very precarious convalescence. We cannot account for this recovery and regard it as a miracle. In nineteen patients who had obstruction about old adhesions or bands in the peritoneal cavity, there were four deaths. In one patient, a woman of seventy-four, the condition was critical at entry. She had been obstructed three to four days. The non-protein nitrogen of the blood was 88 and the chlorides 398 at the time of admission. A low enterostomy was done under local anæsthesia but it was of no avail. The second death occurred in a girl of five who was admitted twenty-four hours after her obstruction in rather precarious condition. She did not survive simple release of the obstructing band. There was enormous distention of the small bowel and apparently absorption of toxins had overwhelmed her. In the third case, a surgical error must be held as responsible for the death. This man of fifty-four had a definite band across his terminal ileum which was released. The operator then traced back the bowel to what he supposed was Treitz's ligament. At autopsy this band turned out to be a band obstruction across a high jejunal loop. The bowel above was distended and death had occurred through rupture of a necrotic patch and peritonitis. The fourth fatality was in an eighty-four-year-old woman, with generalized carcinomatosis. The obstructed small bowel had been drained through an enterostomy. The patient's family wisely refused operation for relief of the obstruction with such a hopeless prognosis ahead.

In twenty-one patients with acute peritonitis complicated by obstruction, there were five deaths. Many of these obstructions came on while the patient was convalescing from some acute visceral perforation. In this type of patient diagnosis is difficult, and usually operation is delayed as the surgeon hesitates to reopen the abdomen in the presence of peritonitis.

We have learned to differentiate these patients with obstruction on a dynamic basis from those with paralytic ileus and now no longer hesitate to attack the obstruction at its source. We have practically abandoned enterostomy, which would seem to be the simplest therapy to offer these very ill patients. Two of our fatalities occurred in patients who had enterostomies as their only operation. One of these patients had a subhepatic abscess and bronchopneumonia at autopsy, the other, a girl of three years, had a pelvic abscess. We now look upon this treatment as inadequate and think these patients might possibly have been saved. Our third fatality in this group was in a man of forty-seven, who had a volvulus at operation five days after his original laparotomy. Paralytic ileus followed the untwisting of this segment and an enterostomy did not benefit him. The condition in the fourth patient was so desperate that the repeated efforts to rescue him from the multiple adhesions and fistulas were almost certain to result in failure. In his case the surgeon attempted more surgery than his condition would warrant. An organic obstruction which was not recognized until too late was responsible for the fifth death in this series. The patient had had a perforated gastric ulcer, a streptococcus peritonitis and a pelvic abscess, all of which served to mask the true cause of his symptoms. In the group of

patients with obstruction and peritonitis, there have been some amazing recoveries in what appeared to be almost hopeless conditions. We believe we have made more improvement in the treatment of this group than in any other form of obstruction.

It is very desirable that these patients, who undoubtedly have very irritable small intestines as a result of their peritonitis, be placed on a low-residue smooth diet, and perhaps should take mineral oil for several months. We are confident that a heavy meal with high roughage has brought on acute obstructions in two instances in this series (Cases 10,581 and 18,198).

There have been 106 cases in this series with thirty deaths—28.5 per cent mortality. An analysis of our fatalities indicates that seventeen patients came too late for any therapy—(54 per cent), six patients died of conditions as complications or accidents beyond the control of the surgeon—(20 per cent), diabetic coma, streptococcic septicæmia, pneumonia and lung abscess, boric-acid poisoning, refusal of surgery, too many obstructions and complication, seven deaths may be fairly charged against the surgery itself—(23.3 per cent). In three very ill patients there was too late recognition of a surgical complication which might have been remedied. In one patient there was failure to recognize a second high obstruction. There was a technical error, allowing leakage from a suture line in one instance. And in two cases the operation, enterostomy, may be regarded as insufficient to have relieved the condition. In addition to this, there were probably four errors in judgment in critically ill patients. Two of these errors consisted in too much surgery, and the other two, in the choice of a procedure which is dangerous in itself and fundamentally wrong in principle.

#### *Combined Features of Obstruction and Strangulation Hernias*

No 6030, male, aged fifty-three years. Type of obstruction—Obstructed inguinal hernia. Time since onset—Four hours. General condition—Good. Anæsthesia—Local. Operation—Release, repair. Result—Well.

No 7946, male, aged three months. Type of obstruction—Obstructed inguinal hernia. Time since onset—Six to eight hours. General condition—Good. Anæsthesia—Drop ether. Operation—Release, repair. Result—Well.

No 24,902, male, aged seventy-two years. Type of obstruction—Obstructed inguinal hernia. Time since onset—Five hours. General condition—Fair. Anæsthesia—Local. Operation—Release, repair. Result—Well.

No 28,280, male, aged thirty-nine years. Type of obstruction—Obstructed inguinal hernia. Time since onset—Ten hours +. General condition—Good. Anæsthesia—Gas and oxygen. Operation—Release, repair. Result—Well.

No 28,940, male, aged eighty-one years. Type of obstruction—Obstructed inguinal hernia. Time since onset—Eight to ten hours. General condition—Fair. Anæsthesia—Spinal. Operation—Release, repair. Result—Well.

No 35,973, male, aged forty-two years. Type of obstruction—Obstructed inguinal hernia. Time since onset—Four hours. General condition—Good. Anæsthesia—Spinal. Operation—Release, repair. Result—Well.

No 36,553, male, aged fifty-nine years. Type of obstruction—Obstructed inguinal hernia. Time since onset—Three and a half hours. General condition—Cancer, stomach. Anæsthesia—Local. Operation—Release, repair. Result—Well.

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No 40,976, female, aged fifty-seven years Type of obstruction—Obstructed inguinal hernia Time since onset—Six hours General condition—Obese, good Anæsthesia—Spinal Operation—Release, repair Result—Well

No 43,510, male, aged eighty-three years Type of obstruction—Obstructed inguinal hernia Time since onset—Three hours General condition—Arteriosclerosis, hypertension Anæsthesia—Local Operation—Release, repair Result—Well

No 50,465, male, aged eighty-seven years Type of obstruction—Obstructed inguinal hernia Time since onset—Five and a half hours General condition—Good Anæsthesia—Local Operation—Release, repair Result—Well

No 51,923, male, aged seventy-eight years Type of obstruction—Obstructed inguinal hernia Time since onset—One and a half hours General condition—Good Anæsthesia—Local Operation—Release, repair Result—Well

No 7150, male, aged sixty-one years Type of obstruction—Obstructed inguinal hernia Time since onset—Four days General condition—Bad, non-protein nitrogen, 123.5 Anæsthesia—1, Local, 2, local Operation—Enterostomy, lateral anastomosis Result—Died Remarks—Contents stripped through tube

No 44,697, male, aged two months Type of obstruction—Obstructed inguinal hernia General condition—Bad Anæsthesia—Drop ether Operation—Release, repair Result—Died Remarks—One week post-operative died, streptococcus viridans septicæmia

No 12,088, female, aged fifty-two years Type of obstruction—Obstructed femoral hernia Time since onset—Five hours General condition—Obese, blood-pressure, 200/100 Anæsthesia—Local, ether Operation—Release, repair Result—Well

No 21,528, male, aged seventy-eight years Type of obstruction—Obstructed femoral hernia Time since onset—Two days General condition—Bad, non-protein nitrogen, 100 Anæsthesia—Scopolamine, morphine, local Operation—Release, repair Result—Well

No 23,162, female, aged fifty-two years Type of obstruction—Obstructed femoral hernia Time since onset—Fourteen hours General condition—Fair Anæsthesia—Local, gas and oxygen Operation—Release, repair Result—Well

No 33,491, female, aged sixty-three years Type of obstruction—Obstructed femoral hernia Time since onset—Seven hours General condition—Chronic nephritis, hypertension Anæsthesia—Local Operation—Release, repair Result—Well

No 43,507, male, aged forty-seven years Type of obstruction—Obstructed femoral hernia Time since onset—Six hours General condition—Diabetes Anæsthesia—Local, gas and oxygen Operation—Release, repair Result—Well

No 30,090, male, aged forty-two years Type of obstruction—Obstructed ventral hernia Time since onset—Six hours General condition—Good Anæsthesia—Gas and oxygen Operation—Release, repair Result—Well

No 33,213, male, aged forty-six years Type of obstruction—Obstructed ventral hernia Time since onset—Several hours General condition—Good Anæsthesia—Local Operation—Release, repair Result—Well

No 54,383, female, aged sixty-one years Type of obstruction—Obstructed ventral hernia Time since onset—Twenty-four hours General condition—Good Anæsthesia—Local Operation—Release, repair Result—Well

No 1145, male, aged sixty-nine years Type of obstruction—Obstructed inguinal hernia Time since onset—Sixty hours General condition—Desperate Anæsthesia—Local Operation—Release, repair Result—Died Remarks—No chance, too late

No 24,620, female, aged fifty-three years Type of obstruction—Obstructed ventral hernia Time since onset—Twenty-four hours + twelve hours Refused operation General condition—Weight, 225 pounds Very poor Anæsthesia—Ether Operation—Release, repair Result—Died Remarks—Patient waited too long Hernia size of football

No 37,846, female, aged seventy-five years Type of obstruction—Obstructed

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ventral hernia Time since onset—Five hours General condition—Extreme obesity  
Anæsthesia—Gas and oxygen, ether Operation—Release, repair Result—Died  
Remarks—Paralytic ileus, bursting wound, secondary closure, bronchopneumonia, lung  
abscess, chronic myocarditis

No 35,271, male, aged three days Type of obstruction—Internal hernia into  
lesser peritoneal sac Time since onset—Three days General condition—Fair, non-  
protein nitrogen, 74 Anæsthesia—Drop ether Operation—Release Result—Well  
Remarks—Unusual case, recovered nicely

### *Old Adhesions*

No 14,258, male, aged twenty-six years Type of obstruction—Old adhesions,  
appendix, post-operative Time since onset—Seven and a half hours General condition  
—Good Anæsthesia—Gas and oxygen Operation—Release two places Result—Well  
Remarks—Nine months after appendix operation

No 18,198, male, aged forty-two years Type of obstruction—Old pelvic adhesions,  
volvulus Time since onset—Five to six hours General condition—Good Anæsthesia  
—Gas and oxygen, ether Operation—Release Result—Well Remarks—Followed  
heavy meal, non-protein nitrogen, 41.5

No 22,507, female, aged sixty-three years Type of obstruction—Old band adhesions  
Time since onset—Three days General condition—Fair Anæsthesia—Gas and oxygen,  
ether Operation—Release, enterostomy Result—Well

No 22,508, male, aged thirty-nine years Type of obstruction—Old adhesions,  
several obstructions Time since onset—Two hours General condition—Fair Anæsthesia  
—Spinal Operation—Release several bands Result—Well Remarks—Eight  
months after acute peritonitis

No 24,529, male, aged forty-seven years Type of obstruction—Old adhesions previ-  
ous gall-bladder operation Time since onset—Fourteen hours General condition—  
Good Anæsthesia—Gas and oxygen, ether Operation—Release Result—Well

No 25,589, male, aged twenty-nine years Type of obstruction—Old adhesions opera-  
tive scar Time since onset—Forty-eight hours General condition—Fair Anæsthesia  
—Gas and oxygen Operation—Release Result—Well

No 26,978, female, aged forty-five years Type of obstruction—Old adhesions previ-  
ous appendicitis Time since onset—Thirty hours General condition—Good Anæsthesia  
—Gas and oxygen, ether Operation—Release Result—Well

No 26,978, female, aged forty-six years Type of obstruction—Old adhesions,  
previous appendicitis Time since onset—Eighteen hours General condition—Good  
Anæsthesia—Spinal Operation—Release several bands Result—Well Remarks—  
Six months after previous entry

No 30,304, male, aged forty-eight years Type of obstruction—Metastatic cancer,  
adhesions pelvis Time since onset—Gradual, partial, two to three days, complete Gen-  
eral condition—Fair Anæsthesia—Spinal Operation—Ileocolostomy Result—Well  
Remarks—Enormous loops, ileum bound firmly in carcinoma

No 31,698, female, aged twenty-one years Type of obstruction—Old adhesions,  
previous appendicitis Time since onset—Fifteen hours General condition—Good  
Anæsthesia—Spinal Operation—Release Result—Well

No 32,610, male, aged five years Type of obstruction—Old adhesions about old  
enterostomy Time since onset—Twelve hours General condition—Good Anæsthesia  
—Gas and oxygen, drop ether Operation—Release Result—Well Remarks—Old  
enterostomy opened, repaired

No 35,613, male, aged thirty-eight years Type of obstruction—Old adhesions about  
colon Time since onset—Several days General condition—Poor, non-protein nitrogen,  
86, chlorides, 295 Anæsthesia—Ether Operation—Release, enterostomy Result—  
Well Remarks—Condition critical, non-protein nitrogen to 101 post-operative

No 44,368, male, aged sixty years Type of obstruction—Adhesions two previous

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laparotomies Time since onset—Thirteen hours General condition—Good Anæsthesia—Ether Operation—Release band Result—Well

No 46,975, female, aged fifteen months Type of obstruction—Adhesions cong or inflam Time since onset—Five days General condition—Critical, pulse 180 Anæsthesia—Drop ether Operation—Release bands Result—Well

No 50,809, female, aged seventy-six years Type of obstruction—Old bands Time since onset—Twenty-four hours General condition—Very poor, hypertensive heart disease—Anæsthesia—Local, drop ether Operation—Release bands Result—Well Remarks—Non-protein nitrogen, 47

No 2710, female, aged seventy-four years Type of obstruction—Old pelvic adhesions Time since onset—Three to four days General condition—Critical Anæsthesia—Local Operation—Enterostomy (low) Result—Died Remarks—Non-protein nitrogen, 88-115, chlorides, 398-450

No 3292, female, aged eighty-four years Type of obstruction—Old adhesions known cancer metastases Time since onset—Forty-eight hours General condition—Critical Anæsthesia—Local Operation—Enterostomy Result—Died Remarks—Non-protein nitrogen, 58, lived twelve days Family opposed to further operation

No 24,919, female, aged five years Type of obstruction—Old pelvic adhesions Time since onset—Twenty-four hours General condition—Very sick, pulse 180 Anæsthesia—Drop ether Operation—Release Result—Died Remarks—Tremendous distention small bowel

No 28,967, male, aged fifty-four years Type of obstruction—Old adhesions Time since onset—Gradual, partial, one to two days, complete General condition—Bad, hemiplegia, recent Anæsthesia—Ether Operation—Release bands at ileum Result—Died Remarks—Bands about jejunum, mistaken for Treitz's ligament

### *Fresh Adhesions with Peritonitis*

No 7116, female, aged nineteen years Type of obstruction—Pelvic peritonitis adhesions Time since onset—Gradual, complete one day General condition—Good Anæsthesia—Gas and oxygen, ether Operation—Release, enterostomy Result—Well

No 10,581, male, aged sixteen years Type of obstruction—Adhesions, ruptured appendix, peritonitis Time since onset—Gradual, two to three days complete General condition—Poor Anæsthesia—Gas and oxygen, local Operation—Release enterostomy Result—Well Remarks—Desperate type of case, appendicitis, four days post-operative enterostomy, one month post-operative, drainage pelvic abscess, two days later enterostomy, one month later release adhesions, enterostomy

No 13,872, male, aged forty years—Type of obstruction—Adhesions, ruptured appendix, peritonitis Time since onset—Gradual, one to two days complete General condition—Fair Anæsthesia—Gas and oxygen Operation—Jejunostomy, release Result—Well Remarks—Resection and anastomosis of jejunostomy necessary later

No 18,198, male, aged forty-two years Type of obstruction—Adhesions, ruptured appendix, peritonitis Time since onset—Thirty-six days post-operative, two to three days complete General condition—Fair Anæsthesia—Gas and oxygen Operation—Release Result—Well Remarks—Paralytic ileus, enterostomy, release adhesions, resection enterostomy, end-to-end anastomosis

No 18,963, male, aged thirty-eight years Type of obstruction—Adhesions, ruptured appendix, peritonitis Time since onset—Gradual, one day complete General condition—Poor Anæsthesia—Gas and oxygen Operation—Release Result—Well Remarks—Paralytic ileus, enterostomy, release adhesions, resection enterostomy, end-to-end anastomosis

No 22,508, male, aged thirty-nine years Type of obstruction—Volvulus about adhesions to laparotomy wound, appendicitis, peritonitis Time since onset—One to two days complete General condition—Fair Anæsthesia—Spinal, local Operation—



Release, enterostomy Result—Well Remarks—Did not improve after release Enterostomy then done

No 32,610, male, aged five years Type of obstruction—Adhesions, ruptured appendix, peritonitis Time since onset—Gradual, ten days post-operative General condition—Fair Anæsthesia—Spinal Operation—Release, enterostomy Result—Well Remarks—Enterostomy persisted as fæcal fistula for long time Then closed spontaneously

No 39,065, female, aged forty-four years Type of obstruction—Adhesions, ruptured appendix, peritonitis Time since onset—Gradual, eighty-four days post-operative, one to two days complete General condition—Fair Anæsthesia—Gas and oxygen Operation—Release, enterostomy Result—Well

No 39,823, male, aged twenty-two years Type of obstruction—Adhesions, ruptured appendix, peritonitis Time since onset—Gradual, ten days post-operative, one day complete General condition—Poor Anæsthesia—Local, gas and oxygen Operation—Enterostomy, release Result—Well Remarks—Two enterostomies, release adhesions, resection, enterostomy, end-to-end anastomosis, subphrenic abscess

No 41,539, male, aged forty-six years Type of obstruction—Adhesions, ruptured appendix, peritonitis Time since onset—Eight days post-operative, one to two days complete General condition—Poor Anæsthesia—Gas and oxygen, ether Operation—Release Result—Well Remarks—Enormous distention all way to Treitz's ligament

No 41,560, male, aged forty-five years Type of obstruction—Twist about adhesions to laparotomy wound Bleeding gastric ulcer, open wound, secondary closure Time since onset—Ten days post-operative, three days complete General condition—Fair Anæsthesia—Avertin, gas and oxygen Operation—Release Result—Well

No 42,274, female, aged forty years Type of obstruction—Volvulus about adhesions to laparotomy wound Acute cholecystitis, peritonitis Time since onset—Seven days post-operative, two to three days complete General condition—Fair Anæsthesia—Gas and oxygen Operation—Release Result—Well Remarks—Confusion with post-operative dilatation of stomach

No 43,356, female, aged thirty-five years Type of obstruction—Pelvic abscess, appendicitis, peritonitis local Time since onset—Seven days post-operative, one to two days complete General condition—Good Anæsthesia—Gas and oxygen Operation—Release Result—Well

No 52,263, female, aged twenty-five years Type of obstruction—Adhesions pelvis, appendicitis, local peritonitis Time since onset—Gradual, seven days post-operative, one day complete General condition—Good Anæsthesia—Spinal Operation—Release Result—Well

No 52,263, female, aged twenty-five years Type of obstruction—Volvulus about adhesions laparotomy wound Time since onset—Sudden, waited two days General condition—Poor Anæsthesia—Local, ether Operation—Release Result—Well Remarks—Patient critically ill after volvulus Diagnosed as pulmonary embolism at first

No 52,596, male, aged seven years Type of obstruction—Adhesions, appendicitis, peritonitis Time since onset—Gradual, six days post-operative, one day complete General condition—Fair Anæsthesia—Drop ether Operation—Release Result—Well Remarks—Fæcal fistula cæcum, spontaneous closure

No 34,716, male, aged forty-four years Type of obstruction—Adhesions, appendicitis, peritonitis Time since onset—Gradual, ten days post-operative, thirty-six hours complete General condition—Fair Anæsthesia—Spinal, drop ether Operations—Two enterostomies Result—Died Remarks—Subhepatic abscess, bronchopneumonia, unreleased adhesions at post-mortem

No 38,789, male, aged forty years Type of obstruction—Kink about adhesion, laparotomy wound Ruptured gastric ulcer, pelvic abscess Time since onset—Gradual, ten days to two weeks, two to three days complete General condition—Poor Aures-

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thetia—Avertin, local    Operation—Enterostomy    Result—Died    Remarks—Hemolytic streptococcus peritonitis, obstruction diagnosed too late

No 42,311, male, aged twelve years    Type of obstruction—Multiple obstructions, adhesions, appendicitis, peritonitis    Time since onset—Gradual, two and one-half weeks post-operative, complete obstruction one to two days    General condition—Poor    Anæsthesia—Gas and oxygen    Operation—Repeated operations    Result—Died    Remarks—Appendectomy, two weeks post-operative, drainage pelvic abscess, eighteen days post-operative, release obstruction, enterostomy, thirty-two days post-operative, release obstruction, thirty-four days post-operative, lateral anastomosis ileum to colon, forty-eight days post-operative, closure ileocolic fistula, fifty-one days post-operative, same, seventy-seven days post-operative, release multiple adhesions pelvis, resection enterostomy, end-to-end anastomosis    Boy almost moribund    Bad case    Too much surgery at close

No 45,605, male, aged forty-seven years    Type of obstruction—Volvolus about adhesions laparotomy wound    Acute cholecystitis, peritonitis    Time since onset—Gradual, seven days post-operative, complete two days    General condition—Poor    Anæsthesia—Gas and oxygen, ether    Operation—Release    Result—Died    Remarks—Paralytic ileus at autopsy

No 51,868, female, aged two years, eleven months    Type of obstruction—Adhesions, appendicitis, peritonitis    Time since onset—Gradual, fourteen days, one to two days complete    General condition—Poor    Anæsthesia—Drop ether    Operation—Enterostomy only    Result—Died    Remarks—Unreleased adhesions at post-mortem

### *Miscellaneous*

No 269, male, aged twenty-eight years    Type of obstruction—Mesenteric thrombosis    Time since onset—Five days    General condition—Peritonitis, ruptured appendix    Anæsthesia—Local, gas and oxygen    Operation—Enterostomy    Result—Well    Remarks—Bowel Concord grape color    Cannot account for recovery

No 18,754, male, aged four years    Type of obstruction—Intussusception—Time since onset—Eight hours    General condition—Fair    Anæsthesia—Gas and oxygen    Operation—Reduction    Result—Well

No 25,964, male, aged seven months    Type of obstruction—Intussusception    Time since onset—Eight hours, possibly thirty-two    General condition—Poor    Anæsthesia—Drop ether    Operation—Reduction, lateral anastomosis    Result—Well

No 27,833, female, aged six months    Type of obstruction—Intussusception    Time since onset—Twelve hours    General condition—Good    Anæsthesia—Drop ether    Operation—Reduction    Result—Well

No 3335, male, aged twenty-five years    Type of obstruction—Through tear in mesentery    Time since onset—Nine hours    General condition—Good, non-protein nitrogen, 66    Anæsthesia—Local, gas and oxygen    Operation—Lateral anastomosis, enterostomy    Result—Well    Remarks—Resection involved loop several months later

No 23,505, male, aged thirty-three years    Type of obstruction—Through tear in mesentery    Time since onset—Eleven days—General condition—Poor    Anæsthesia—Ether    Operation—Release, enterostomy    Result—Died    Remarks—Peritonitis present    Too late for surgery

No 27,172, male, aged thirty-eight years    Type of obstruction—Through tear in mesentery    Time since onset—Two days    General condition—Poor    Anæsthesia—Gas and oxygen, ether    Operation—Release, stripping of bowel, enterostomy    Result—Died    Remarks—Late case    Wisdom of surgery questionable

No 44,626, male, aged forty-one years    Type of obstruction—Complete obstruction at terminal ileum, cancer of cæcum    Time since onset—Two days    General condition—Fair, non-protein nitrogen, 46    Anæsthesia—Ether    Operation—Ileocolostomy    Result—Well    Remarks—Resection cancer ascending colon later

No 42,674, female, aged forty-four years    Type of obstruction—Gall-stone obstruc-

tion Time since onset—Five days General condition—Poor Anaesthesia—Ether  
Operation—Removal of stones, gastroenterostomy Result—Died Remarks—Late  
case Too much surgery

COMPLETE SERIES

Simple obstruction, seven cases, two deaths, 28.5 per cent, strangulation complete, twenty-two cases, eleven deaths, 50 per cent, strangulation partial, two cases, no deaths, combined obstruction and strangulation, seventy-four cases, seventeen deaths, 22.9 per cent Total, 105 cases, thirty deaths, 28.5 per cent

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# LYMPHOSARCOMA OF THE SMALL AND LARGE INTESTINES

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A SEARCH of the literature on the subject of lymphosarcoma of the intestines reveals a marked diversity of opinion concerning its morphology, histogenesis and etiology. This state of affairs is further complicated by the lack of any uniform nomenclature. As Ewing pointed out, there has prevailed for many years an inadequate clinical classification of lymphoid tumors, *viz*

(1) Inflammatory hyperplasia—simple tumors, response of lymphoid tissue to bacterial or toxic irritants

(2) Neoplastic tumors—uncommon tumors, atypical growths, unknown etiology

(3) Intermediary types—uncommon tumors, diffuse enlargements, unknown etiology

Recognizing the deficiencies of such a classification, Ewing has classified lymphoid tumors from the standpoint of histogenesis and structure. The cellular elements of lymphoid tissue that may give rise to tumors are (1) lymphocytes, (2) reticulum cells of the follicles and pulp, and (3) endothelial cells of the pulp and cavernous sinuses

<i>Origin</i>	<i>Anatomical Types</i>	<i>Clinical Types</i>
Lymphocyte	Lymphocytoma	Simple lymphoma, tuberculous lymphoma, lymphatic leukemia, pseudoleukemia, malignant lymphocytoma (lymphosarcoma)
Reticulum cells	Large round-cell, hyperplasia, or neoplasia	Granuloma malignum, myeloid leukemia, Hodgkin's sarcoma, large-cell sarcoma (lymphosarcoma)
Endothelial cells	Endothelial hyperplasia or neoplasia	Endothelial hyperplasia of tuberculosis, <i>etc</i> , endothelioma

Thus there are two types of lymphosarcoma which may arise from lymphoid tissue (1) Malignant lymphocytoma, (2) reticulum-cell sarcoma (large round-cell lymphosarcoma). In many instances, the two histological types appear to maintain their identity and are associated with different clinical conditions and different etiological factors. But, despite the fact that the individuality of the two types has been established, they are still considered under one heading because of the indefinite relation of the lymphocyte to the reticulum cell.

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Kundrat was the first to isolate lymphosarcoma from the group of closely allied diseases of the lymphatics, all of which were included under the term pseudoleukemia or lymphosarcoma, and also described the clinical characteristics. He showed that the origin of this tumor was in the lymph-nodes or adenoid tissue elsewhere in the body. He pointed out that systemic effects were rarely noted in lymphosarcoma in contradistinction to what is found in leukemia and pseudoleukemia.

Ewing states that the structure of lymphosarcoma is somewhat specific. The tumor presents a diffuse growth of lymphoid cells which tends to obliterate the structure of the affected node or follicle. The individual cells may vary in size, being small, of medium size, or large. Occasionally, large multinucleated cells are seen, but giant cells only rarely. The stroma of the tumor shows no regular form but is more likely to be of irregular distribution. In some areas, the reticulum is deficient, in others, it is diffuse with a tendency to fibrosis. Regressive changes are seldom seen, but the occlusion of blood-vessels, especially in bulky growths, may occur and lead to ulceration.

In the same cases of lymphosarcoma, there may be found among the lymphoid cells such cellular elements as plasma cells, eosinophiles and lymphocytes whose presence signify an infectious process and tend to obscure the diagnosis of lymphosarcoma.)

*Terminology*—Lymphosarcoma of the intestines has been written about under various names. It is most frequently reported as "sarcoma" of either the small or large round-cell type. The tumor has also been reported as lymphocytoma, lymphoblastoma, intestinal Hodgkin's disease, chronic inflammatory tumor, lymphoid granulation tumor and granulomatous pseudoleukemia. These names are frequently used interchangeably. (Graves has strongly advocated the use of the term "lymphoblastoma," which, according to Mallory and Ribbert, is a tumor of mesenchymal origin and the cells of which tend to differentiate into cells of the lymphocyte series. He points out that "sarcoma" should be applied only to tumors of mesenchymal origin with cells which tend to differentiate like fibrous or mucous connective tissue, muscle, bone, or cartilage cells. Minot and Isaacs suggest the use of the terms "lymphoblastoma" or "malignant lymphoma" to include all types of malignant lymphoid tumors, such as lymphatic leukemia, pseudoleukemia or aleukemic lymphatic leukemia, Hodgkin's disease and lymphosarcoma.)

Webster believes that lymphosarcoma, lymphatic leukemia and leukosarcoma are different manifestations of the same disease which he proposes to call lymphadenosis, leukemic or aleukemic. He believes that it represents a neoplasm that is formed as a direct response on the part of the lymphocytes to a chemotactic influence exerted by the disease-causing agent. He believes that a localized lymphosarcoma may, under certain conditions, become generalized and with a blood picture of lymphatic leukemia, may terminate as a leukosarcoma ;

However, for the want of a better name, for the present we shall adhere to the term "lymphosarcoma," at least until the histogenetical and morphologi-

cal characteristics and relationships of the structural components of these tumors are more clearly established )

Marked differences of opinion exist in regard to the clinical picture presented by this tumor and the appropriate treatment. However, since no one surgeon or clinic has had a series of cases sufficiently large to warrant definite clinical conclusions, it may not be out of place to quote extensively the opinions of the various contributors to this subject. Our own opinion and conclusions are based on a comprehensive statistical study of 126 cases.

*Incidence*—After an extensive review of the literature, we feel that a complete and accurate compilation of the cases of primary lymphosarcoma of the intestines is well-nigh impossible for several reasons.

(1) Owing to the marked variation and interchangeability in the terminology accorded to these tumors, the majority of the cases of true lymphosarcoma of the intestines have been reported as other types of tumors. The condition is most frequently reported as "sarcoma," and often the correct diagnosis and proper classification were made only after careful study of the pathological data in the cases reported.

(2) In many cases, the pathological report was absent or incomplete, and often other data (regarding age, sex, site of tumor, duration, *etc.*) were insufficient to supply a definite diagnosis.

(3) One of the greatest difficulties encountered in the tabulation of the cases is the checking up and tracing of incomplete or incorrect references.

However, our task has been considerably lightened by the excellent articles by Crowther and Graves. In 1913, Crowther collected 191 cases of "sarcoma" of the small intestine. In this series, there were 119 cases of the lymphosarcoma type, to which the author added three cases. Graves reviewed the literature up to June, 1919, and reported a total of 249 cases, including three cases of his own. We have collected 125 additional cases and add one case of our own, making a total of 375 cases. In our series, there are included eight cases diagnosed at autopsy—Staemmler (two cases), Molson, Ablon, Clopton, Hulbert, Zimmer and Bensaude, Cain and Horwitz.

An idea of the difficulties encountered in the proper classification of "sarcomatous" tumors of the small intestines can be gathered from a review of Crowther's findings. In his series of 191 cases, he found small round-cell sarcoma, 68, lymphosarcoma, 48, spindle-cell sarcoma, 22, myosarcoma, 7, melanosarcoma, 5, fibrosarcoma, 4, large round-cell sarcoma, 3, myosarcoma, 3, endothelial-cell sarcoma, 3, polyform-celled sarcoma, 2, mixed-cell sarcoma, 2, fibromyosarcoma, 2, osteosarcoma, 1, and 21 undifferentiated tumors which were reported simply as "sarcoma." From this list, as noted by Graves, one can obtain 119 cases of lymphosarcoma or lymphoblastoma, which include the cases of small round-cell sarcoma, large round-cell sarcoma and lymphosarcoma.

From the 126 cases collected by the present authors, we have the following pathological diagnoses: Lymphosarcoma, 82, lymphoblastoma, 2, lymphocytoma, 1, round-cell sarcoma, 17, small round-cell sarcoma, 7, large round-cell sarcoma, 3, lymphosarcoma or round-cell sarcoma, 1, sarcoma with infiltrating eosinophils, 1, small round-cell sarcoma of lymphoid type, 1, lymphoid sarcoma with acute malignant lymphogranulomatosis, 1, large round-cell sarcoma of endothelial type, 1, round-cell embryonic fibroma, 1, chronic inflammatory tumor, 4, chronic inflammatory tumor or sarcoma, 3, and chronic inflammatory tumor or large round-cell sarcoma, 1.

The relative rarity of lymphosarcoma of the intestines is borne out by the observations of the early contributors whose studies were based on "primary sarcoma." Libman

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states that not a single case of primary sarcoma of the intestines was observed in the Berlin Pathological Institute from 1859 to 1875. Nothnagel reported only nine cases of sarcoma in 21,358 autopsies in the General Hospital of Vienna from 1882 to 1893. Smoler found only thirteen cases of primary sarcoma of the small intestines in 13,036 autopsies between the years 1883 and 1898 at the Prague Pathological Institute.

Nothnagel's figures are interesting in this respect. He found 243 cases of carcinoma of the intestines in 2,125 autopsies on carcinoma cases and three cases of sarcoma of the intestines in 274 autopsies on sarcoma cases. Mueller reported 521 cases of carcinoma with forty-one of the intestinal type and 102 cases sarcoma with one of the intestinal type. Warthin reported only two cases of lymphosarcoma of the small intestines in an analysis of 2,000 malignant neoplasms in young people between one and thirty years of age examined in the Pathological Department of the University of Michigan. Staemmler found thirty-three cases of sarcoma of the intestines in an analysis of 54,000 autopsy protocols obtained from the combined records of German and Austrian hospitals.

W. Fisher reviewed the records of the Royal Prince Alfred Hospital in Sydney, Australia, from 1910 to 1925, and found five cases of sarcoma in a series of 265 cases of



FIG 1



FIG 2

FIG 1—A section taken from the edge of the tumor, demonstrating the diffuse nature of the growth. The tumor, arising in the submucosa, has invaded and destroyed the muscularis. The mucosa is elevated and fairly well preserved in this region, but in one portion is invaded by tumor cells. (x 5)

FIG 2—Sections taken from the central portion of the tumor mass, showing marked invasion and destruction of all the intestinal layers. The involvement of the mucosa varies from slight compression and distortion to complete degeneration and necrosis. (x 5)

malignant disease of the large and small intestines, excluding the rectum. Among 182 cases of malignant disease of the rectum and anus, there were no cases of sarcoma. Sarcoma of the stomach was not included in this review. Loria studied the records of the Charity Hospital of New Orleans from 1914 to 1923, inclusive, and found forty-four cases of intestinal carcinoma among 1,817 carcinomas (excluding gynecological carcinomas) and seven cases of intestinal sarcoma among 431 cases of sarcoma.

Vercellotti found seven cases of sarcoma of the intestines in 14,585 autopsies (4 per cent) and in 1,345 cases of malignant tumors of the entire body (0.53 per cent). Of the 114 cases of malignant tumors of the intestines, seven were sarcomas (6.14 per cent) and 107 were carcinomas. In a study of twenty-three cases of tumor of the small intestines, Puccinelli found lymphosarcoma, seven cases, carcinoma, seven cases, and sarcoma, two cases. The largest series of lymphosarcoma of the intestines collected in one clinic in this country is reported by Rankin and Chumley from The Mayo Clinic and comprises eighteen cases of lymphosarcoma of the large bowel.



In an earlier paper, Bull stated that the relation of these tumors is about one sarcoma to twenty carcinomas. He pointed out that sarcoma may be found in the small or large intestine or rectum, whereas carcinoma is more frequent in the large intestine. Rankin stated that while lymphosarcoma of the small intestine is of relatively infrequent occurrence as compared with carcinoma of the entire intestinal canal, it is perhaps found as frequently in the small bowel as any form of malignancy.

Staemmler reports the incidence of sarcoma of the intestine at autopsy as 0.06 per cent and carcinoma of the intestines at autopsy as 1 per cent. He concludes that the proportion of sarcoma to carcinoma of the intestine, as established at the post-mortem table, is about one sarcoma to sixteen carcinomas, while in surgical practice (biopsies), based on statistics of German and Austrian surgeons, it is about one sarcoma to 100 carcinomas.

(Lymphosarcoma is more frequent in the small intestine than in the large intestine, not excluding the rectum. This fact is attested by a review of our own and of other statistics.)

The anatomical location of the tumor in the 126 cases collected by the authors is as follows: Duodenum, 4, duodenum and stomach, 1, duodenum and jejunum, 1, jejunum, 17, jejunum and ileum, 4, ileum, 36, ileocecal portion, 8, "small intestines," 15, "small intestines" and stomach, 1, appendix, 2, appendix and cæcum, 1, cæcum, 17, ascending colon, 2, transverse colon, 1, descending colon, 2, sigmoid, 4, rectum, 8, rectum and sigmoid, 1, ascending colon, cæcum, ileum, and jejunum, 1, descending colon, sigmoid, and jejunum, 1, and "intestines," 1. Further analysis of these figures shows that the small intestine was the site of the tumor in seventy-seven cases, the large intestine (including the cæcum) in thirty-two cases, and ileocecal region in eight cases. The most common location for the tumor was the ileum (thirty-six cases) and next in order, the jejunum and cæcum (seventeen cases each). These findings are in accord with the general belief that lymphosarcoma is found more frequently in the small than in the large intestine, and that the ileum is involved more often than any other portion of the intestinal tract.

In his series of 191 cases of sarcoma of the intestines, Crowther found the exact location mentioned in 129 cases, and these included: Duodenum, 12, duodenum and jejunum, 7, jejunum, 32, jejunum and ileum, 8, ileum (chiefly in terminal portion), 55, cæcum, 8, diffused throughout the intestine, 8. In Comer and Fairbanks series of 175 cases of "sarcoma" of the alimentary tract, the site was noted as follows: Oesophagus, 14, stomach, 58, ileocecal region, 20, colon, 11, rectum, 7. Goldstein has recently collected 592 cases of primary sarcoma in the alimentary tract and found the location mentioned. In the oesophagus, 21, stomach, 265, large and small intestine, 130, appendix, 17, liver, 59, gall-bladder, 16, pancreas, 19, tongue, 65. Staemmler collected 400 cases of sarcoma of the intestinal tract, which included ten personal observations from the laboratory of the Chemnitz Pathological Institute. The site of the lesion was recorded in 394 cases and included the duodenum, 34, jejunum, 44, ileum, 79, small intestines, 61, cæcum and ileocecal coil, 45, appendix, 12, colon, 16, sigmoid, 4, rectum, 91, large intestine, 8.

Friend collected nineteen cases of lymphosarcoma of the appendix. He also reported one case of his own, and to this series may be added the case reported by Hagyard. Liu reported twelve cases: Ileum, 9, cæcum, 2, and sigmoid, 1.

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In Weeden's series of thirteen cases of lymphosarcoma of the gastro-intestinal tract, the location of the tumor was found to be in the small intestine, 10, large intestine, 2, and stomach, 1. In the series of eighteen cases of lymphosarcoma of the large intestines reported by Rankin and Chumley, the site of the lesion was in the cæcum, 13, descending colon, 1, sigmoid, 1, rectum, 3. Vercellotti also noted that sarcoma was found more frequently in the small than in the large intestine. The site of the lesion in his seven cases was Duodenum, 2, small intestine, 3, cæcum, 1, rectum, 1.

From an analysis of the above statistics, it is evident that lymphosarcoma may be found in any portion of the intestinal tract, but that the ileum is the most common site for this tumor. However, it is interesting to note that Libman found the duodenum to be as common a site as the ileum. His series of fifty-nine cases of primary sarcoma of the small intestines included the following: In the duodenum, 15, jejunum and ileum, 18, ileum, 14, entire intestinal tract, 3.



FIG 3

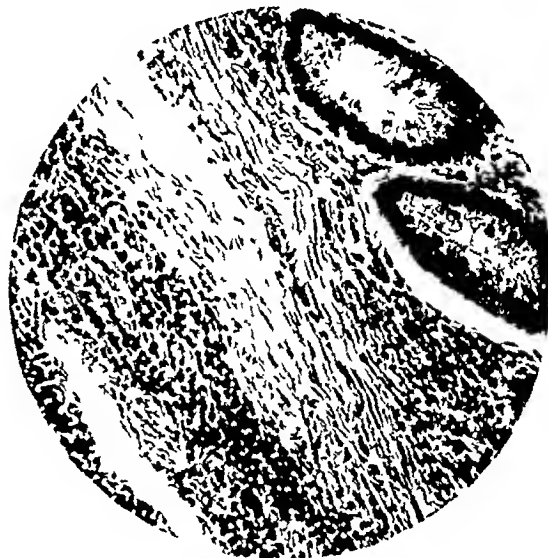


FIG 4

FIG 3—Invasion of the mucosa by tumor cells was noted in practically all sections of the tumor. This section was taken from the edge of the tumor mass ( $\times 150$ .)

FIG 4—Photomicrograph showing the diffuse infiltration of the mucosa, submucosa, and muscularis, by the tumor ( $\times 150$ .)

*Age*—Lymphosarcoma of the intestines may occur at any age, but is most frequently found in the first, third, and fourth decades, as noted in the tables compiled by Graves, Crowther, and the authors. Rankin states that the age of the individual should have some significance in the diagnosis of lymphosarcoma, which he considers a disease associated with early childhood or young adult life. Lymphosarcoma of the intestines has also been known to occur in elderly people. Weeden reported a case in a female, eighty-four years old.

The frequency of the tumor in childhood is striking. Five of the twelve cases reported by Liu occurred in the first decade. Successful operations for this condition in children five to six years of age have been reported by Power, Barling, and Zwahlenburg. Goodman reported a case of lymphosarcoma of the sigmoid in a child of four years. In a case reported by Stern,

the tumor was present at birth and caused intestinal obstruction from which the patient died

In Libman's series of fifty-nine cases of "sarcoma" of the small intestines, more than 50 per cent had occurred between the ages of twenty and forty years. The youngest patient was five days old and the oldest twenty years. In the series of eighteen cases of lymphosarcoma of the large intestines reported by Rankin and Chumley, the youngest patient was eleven years and oldest seventy years. Three of the patients were less than thirty years old, and all of these cases occurred in the second decade. The average age incidence was 45.4 years.

The figures for age incidence in our series (excluding the series reported by Rankin and Chumley) are given below. (The average age for the 106 cases reported is 33.19 years, which is decidedly lower than that reported by Rankin and Chumley.)

AGE INCIDENCE					
<i>Crowther's Series</i>		<i>Graves' Series</i>		<i>Our Series</i>	
Years	Cases	Years	Cases	Years	Cases
1-10	24	1-5	13	1-5	7
		6-10	11	6-10	11
10-20	12				
		11-15	2	11-15	5
20-30	36	16-20	6	16-20	5
30-40	32	21-25	8	21-25	6
		26-30	9	26-30	9
40-50	32				
		31-35	12	31-35	19
50-60	17	36-40	9	36-40	13
60-70	4	41-45	5	41-45	2
		46-50	3	46-50	6
70-80	2				
		51-55	3	51-55	3
		56-60	2	56-60	8
		61-65	1	61-65	6
		66-70	1	66-70	4
				71-75	1
				76-80	0
				81-85	1

*Sex and Race*—All writers upon the subject agree that males show a greater predisposition to the disease than females. According to Speese, Liu, and Weeden, sarcoma of the intestines occurs in males more frequently than in females, in the ratio of two to one. Rankin stated that the sex incidence is equal as regard lymphosarcoma of the small intestine. Graves states that males were affected about three times as often as females. Rankin

and Chumley, in their series of eighteen cases of lymphosarcoma of the large bowel, noted thirteen males and five females. Our studies on the sex incidence are in accord with Graves', inasmuch as in our series there were ninety males and thirty-six females.

Lymphosarcoma of the intestines affects the Negro as well as white people. Liu states that the ratio is four whites to one Negro. This appears to be a rather high percentage and in a large series the proportion of involvement in the Negro is undoubtedly much smaller. In our study, there were forty-three white, three black (Liu's cases). In eighty-three cases the race was not mentioned, but presumably the patients were of the white race.

*Etiology*—The causative factors in the production of lymphosarcoma of the intestines have not been clearly established. Trauma is mentioned in some of the reported cases and may be of some etiological importance. It is a strange coincidence that the tumor occurs much oftener in people of the working class. Single traumatic insults have long been considered of importance in the development of sarcoma in general, as evidenced by the numerous cases reported by Coley, Lowenstein, and others. Zwahlenburg reported a case of a tumor of the small intestine in a five-year-old boy that developed at the site of the injury six weeks after an abdominal trauma. Peterson, in his series of eighty-five cases, found three in which the tumor occurred six to ten weeks after a severe contusion of the region involved.

In the case reported by Coley, the patient gave a history of striking the abdomen with the elbow after falling eighteen feet. The accident had occurred six or seven months before he consulted the physician. Loria's patient sustained an injury to the left half of the abdomen as a result of being struck by a wheelbarrow. The accident occurred three months prior to consultation and operation. Simoncelli's patient received an injury to his left flank which resulted in severe abdominal pain and other symptoms of intestinal obstruction. At operation, at this time, a lymphosarcoma of the jejunum was found.

The German writers consider direct traumatism, bowel injuries from falls, blows and contusions, as the most frequent etiological factor in the development of lymphosarcoma of the intestines. In the development of carcinoma of the intestinal tract, they stress the etiological rôle of chronic irritation, inasmuch as carcinoma occurs most often at the friction points in the intestinal canal, *i e*, at the cardia, pylorus, ileocecal valves, flexures of the colon, rectum and anus. Vercellotti stated that traumatic factors are most important in the development of sarcoma of the intestines, more so than in carcinoma.

The association of tuberculosis and lymphosarcoma elsewhere in the body has been observed, but is regarded as an accidental association, despite the fact that the tubercle bacillus has been found in lymphosarcomatous growths and that occasionally lymphosarcoma may strongly resemble or be indistinguishable from certain infectious granulomas occurring in the gastro-

intestinal tract, such as a hypoplastic tuberculosis. According to Mikulicz, a combination of tuberculosis and sarcoma, especially of lymphosarcoma, is not unusual.

Nothnagel has reported a case of lymphosarcoma of the small intestines developing in the base of an old tuberculous ulcer. Schmidt (1898) reported a case of lymphosarcomatosis of the jejunum associated with tuberculosis of the lymphatic glands and a tuberculous infection of the right lung. The latter author states that, although there is no connection between the tuberculosis and lymphosarcoma, they might possibly possess a common source in the sense of a "hereditary constitutional anomaly." One of the patients in the series reported by Rankin and Chumley had a healed pulmonary tuberculosis. Two of Puccinelli's patients had a pleuritis suggesting tuberculosis, despite the fact that the sputum of one was negative. Friend noted tubercles in the appendix and also in the omentum, at the time of operation. Wortman found tuberculosis of the mesenteric nodes in one of his cases of intestinal lymphosarcoma.

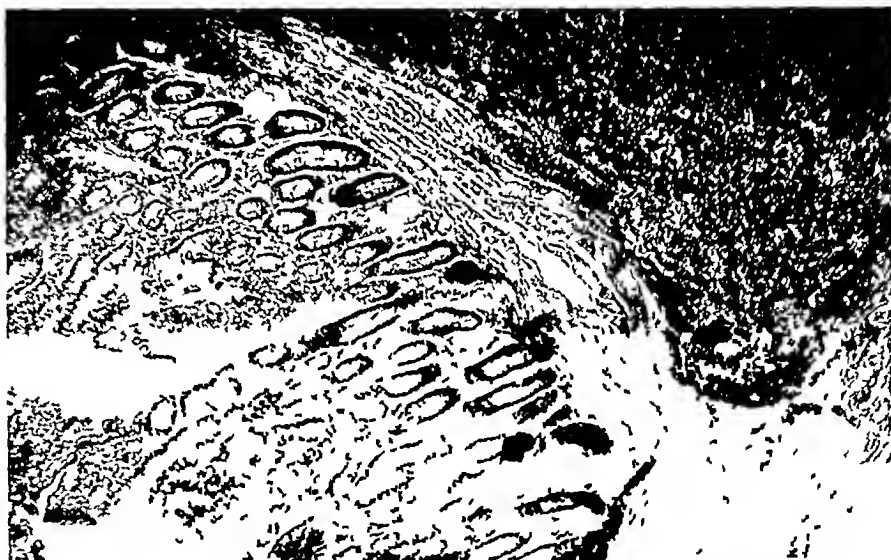


FIG. 5.—Photomicrograph illustrating the origin of the tumor in the submucosa from one of the Peyer's patches. Normal mucosa is seen above the tumor tissue. No germinal centres are noted in the lymphoid zone. (x 600)

The relation of tuberculosis to malignant disease, more particularly to carcinoma than to sarcoma, has been studied by Broders at The Mayo Clinic. He reported that in twenty cases of tuberculosis and malignant disease, the two conditions occurred in the same organ or tissue eight times (40 per cent), in seven cases (35 per cent) the two conditions were actually associated in the same microscopical field.

Opinions vary as to the etiological relationship of syphilis to lymphosarcoma. Schmidt states that an antecedent history of syphilis in lymphosarcoma cases is not common. Von Eschmarch found that more than one-half of the patients with various types of sarcoma had syphilis. In cases reported by Douglas, Koch, Guliani, and Hulbert, there was a history of syphilis. Berghausen has reported two cases of generalized lymphosarcomatosis in syphilitic patients.

In the authors' review of the literature, several cases presented an interesting history of antecedent or intercurrent disease, the etiological relationship of which is not quite clear. Cases of intestinal lymphosarcoma occurring years after typhoid fever have been reported by Cabot, Rankin, and

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Graham One of the patients in Rankin and Chumley's series of lymphosarcoma of the large intestine (also reported by Bargaen) gave a history of chronic ulcerative colitis antedating the development of the malignant tumor. In one of the cases reported by W. Fisher, a man, sixty years old, had been addicted to eating white sand, the other patient, a woman sixty-seven years, had had six pregnancies. Hulbert's patient was treated for severe alcoholism in addition to syphilis. Generalized icterus with hepatic and splenic enlargement due to stricture of the common duct and obliteration of the pancreatic ducts was present in Ablon's patient and evidently had no etiological bearing on the associated intestinal tumor.

Previous operations had been performed in several cases. Firth noted the development of a lymphosarcoma five months after operation for a strangulated hernia. One of Geister's patients was likewise operated upon for a right incarcerated hernia, but the pain persisted and a second operation disclosed a lymphosarcoma of the jejunum. In Graham's case, an operation for intussusception had been performed six weeks before an operation for a tumor at the ileocecal valve. Appendectomies had been performed in the cases reported by Simoncelli, Beer, and Weedon.

Certain writers, particularly De Noyelles and Webster, believe that the lymphoid cells proliferate wildly in the presence of some irritation, chemical or bacterial in nature. De Noyelles stresses the importance of chronic irritation or a specific toxin in the development of these tumors. He points out the histological resemblance of lymphosarcoma to an infectious granuloma and suggests that lymphosarcoma may be but a bizarre or later form of Hodgkin's disease or lymphoblastic or lymphocytic leukemia. Bunting and Huston have shown that the lymphocytes in the blood-stream migrate into the intestinal mucosa to function normally. It is conceivable that these lymphocytes may assume a perverted function and grow wildly in the presence of some abnormal irritant.

*Symptomatology*—There is no clinical picture absolutely characteristic of this disease. The condition may be insidious in onset or may be ushered in as an acute abdominal catastrophe. The type and character of the symptoms are varied and appear to be more or less dependent upon the duration of the growth and the degree of intestinal obstruction caused by it. In the analysis of the cases in our series, we found fifteen cases of acute intestinal obstruction, eleven of chronic obstruction, four of acute obstruction superimposed upon a chronic type, but in the remainder, information relative to the occurrence and type of obstruction was meagre or absent.

The duration of the illness was mentioned in seventy-five cases. In several cases, the symptoms were acute (less than twenty-four hours) and necessitated immediate operation. In the majority of the cases, symptoms had been present over a longer period of time, varying from one day to ten years. The various time intervals for the duration of symptoms in the above series is indicated in the following table.

1 to 24 hours	2 cases	6 to 12 months	5 cases
1 to 7 days	4 cases	1 to 2 years	10 cases
1 to 4 weeks	10 cases	2 to 5 years	7 cases
1 to 6 months	34 cases	5 to 10 years	3 cases

The average duration of the illness was 258 days, or 8 6 months

When the tumor completely occludes the lumen of the intestine as a result of intussusception, adhesions or invasion of the intestinal wall by the growth, symptoms of abdominal ileus may ensue. If the obstruction of the intestines is only partial, the patient may show the symptoms of a chronic intermittent intestinal obstruction. It should be borne in mind that intussusception secondary to tumor formation is seldom accompanied by the usual symptoms associated with intussusception in children. Occasionally there is an absence of severe abdominal pain, vomiting and bloody or mucous stools in adults despite invaginations. The absence of these latter symptoms in adults is most likely due to the fact that complete obstruction is rather uncommon but instead there occurs a dilatation of the infiltrated wall. In cases with partial stenosis of the intestinal lumen, the patient readily adjusts himself to narrowed intestinal passage.

Abdominal pain occurs practically in every case. It was present in seventy-nine cases in our series and not mentioned in the remaining cases. As a rule, the pain is constant, and is confined to the part of the abdomen where the tumor is situated, but it may be more or less generalized over the entire abdomen when an acute obstruction is present, and localized in a chronic obstruction. The pain is of an indefinite nature and frequently colicky in character but is not affected by eating. Ochsner points out that the indefinite abdominal pain accompanying this disease is persistent and differs from the pain in the common chronic abdominal infection in that it is not relieved by rest and starvation.

There is always some bowel disturbance associated with this disease. Bowel movements are frequently irregular, as indicated by the thirty-six cases noted with constipation as a prominent symptom. The stools may occasionally contain blood, as happened in eighteen of our cases, or mucus. Constipation alternating with diarrhoea was present in twenty-three cases. This latter symptom complex and the less frequent occurrence of intestinal hæmorrhage offers two distinctive findings that are more or less characteristic of lymphosarcoma of the intestines. The alternating constipation and diarrhoea is due to the accumulation and stagnation of the fecal contents in dilated and paralyzed pouches which are incapable of peristalsis until the toxic contents of the dilated portion cause contractions of the bowel wall above it and force the contents out through the gut below, so that there results a fetid diarrhoea. Repeated attacks of obstinate constipation may occasionally be noted, but constipation is not common unless there is acute obstruction due to kinking of intestines or to intussusception. Tenesmus is a rather common symptom.

The patients are usually thin, anæmic, and cachetic, especially those with

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a tumor of long duration.<sup>7</sup> However, in some cases, the patient may appear as a healthy, robust individual who had developed an acute abdominal infection. There may be a loss of appetite with gradual loss of strength. Nausea and vomiting are commonly present, although they were noted in but six and twenty-five cases, respectively. Hematemesis occurred in only one case (Cabot's). Changes in temperature and pulse are noted as the degree of obstruction increases. In a case reported by Booth, the temperature chart simulated that of typhoid fever. In sixteen cases, elevations of temperature are recorded.

The abdominal findings are not constant. Tenderness, diffuse or localized, is usually present, but is definitely mentioned in only eighteen cases. A tumor mass may be found in various parts of the abdomen, but is noted most frequently in lower quadrants. An abdominal tumor mass was present in fifty-eight cases, absent in eleven cases and not mentioned in the remainder.

The tumors may vary considerably in size, usually they are as large as a hen's egg, or a fist, but they may attain the size of an adult's head. In several cases, the presence of a large tumor mass was detected by the patient. The presence of a sausage-shaped tumor together with symptoms of chronic intestinal obstruction may be considered distinctive of the intussusception accompanying this disease. In an early case on palpation, the tumor is freely movable and the surface is smooth, though often somewhat irregular. In the later cases, the primary growth is palpated with extreme difficulty owing to the presence of numerous metastatic nodules. The presence of abdominal distention resulting from the accompanying intestinal obstruction interferes with palpation, especially in the late cases. Ewald and Kasemeyer made a correct diagnosis of this disease on the basis of such a palpable tumor. Occasionally, the pressure of the tumor on the large vessels of the abdomen may produce ascites, oedema of the legs, or distention of the veins of the abdominal and thoracic walls. In rare instances, the tumor mass has been noted to encroach upon the liver, biliary vessels and ducts and to produce jaundice. Disturbances in urination such as dysuria, frequency, and diminution of output of urine may result from the interference by the tumor mass with proper kidney and bladder function.

*Gross Pathology*—Lymphosarcoma of the intestines may appear as an annular or polypoid growth, or both types may be present in the same individual.<sup>8</sup> The annular type is more common than the polypoid. In our series, the former type was noted in thirty-two cases, the latter in twenty-six cases, the type was not mentioned in sixty-eight cases. The annular type is usually a single growth, whereas the polypoid may be multiple. On the other hand, the annular type may be very large and extensive and involve more than one loop of gut. The latter type of tumor has sometimes been termed the diffuse type of intestinal lymphosarcoma, and made up thirteen of the cases in our series. Of the twenty-six polypoid cases, fourteen were single and twelve multiple. In the polypoid type, the multiple growths appear as more or less localized outgrowths projecting from the intestinal wall.



into the lumen ( They usually vary in size from that of a pea to that of a walnut, but may be even larger The small tumors have a fungoid appearance on the surface)

In forty-six cases of Lecene, the growth was single in thirty instances and multiple in sixteen cases Liu noted that 60 per cent of his cases were of the annular type, 33 per cent polypoid, and in one case, there was an annular tumor at the ileocecal valve and a polypoid growth in the ascending colon In 75 per cent of Liu's series, the tumor was single, two patients had two tumors each, and one had ten separate growths

Lymphosarcoma of the intestine usually begins in the lymphoid follicles, which are found in the submucosa, especially of the small intestine In the

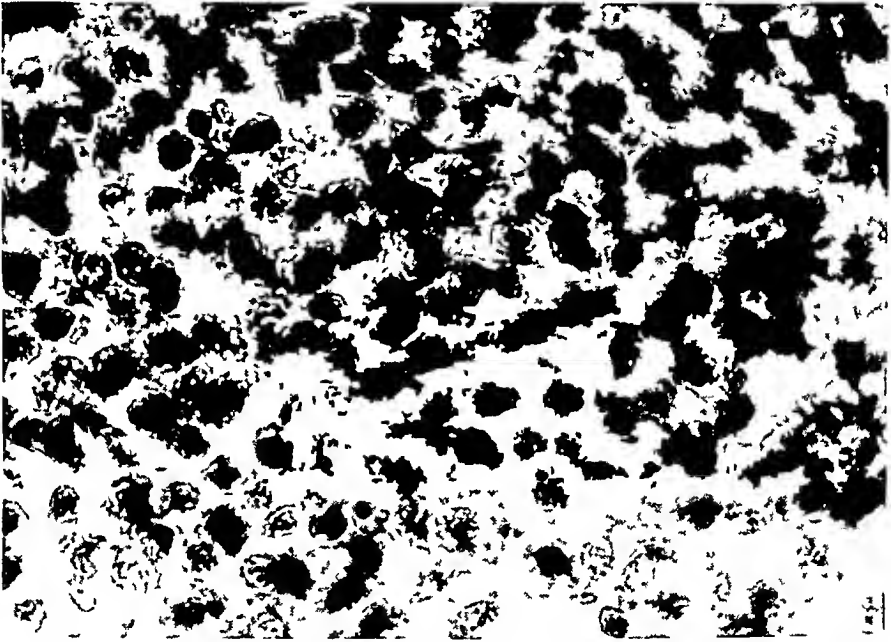


FIG 6—Cellular components of this tumor are predominantly large round cell lymphocytes with an occasional small round cell The large round cells appear to contain a liberal amount of clear cytoplasm and in many instances appear to be multinucleated The stroma is made up of fine reticulated connective tissue In this and other sections there were relatively few blood vessels noted, and these showed no evidence of endothelial hyperplasia or occlusion by tumor tissue No germinal centres or Dorothy Reed cells were seen ( $\times 600$ )

early stages, a localized thickening of the lymphoid follicle is noted which may or may not be accompanied by ulceration of the overlying mucous membrane The tumor gradually invades the other intestinal coats, but rarely penetrates the serosal layer of peritoneum Perforation of the intestine by the growth with a resultant peritonitis may occur, as noted in two cases in our series (Hulbert and Pissarewa) A generalized peritonitis was present in Loria's patient

The tumor spreads laterally through the submucosa and gradually invades and destroys the muscular coats to appear as a subserous tumor The surface of the tumor is not smooth but of an irregular contour, often studded with pebble or pea-sized nodules As the tumor grows, ulceration of the

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mucous membrane occurs and gradually extends into the tumor mass, causing a certain amount of destruction and excavation. The tumor has a rather firm consistency.

There is a decided tendency to aneurismal dilatation of the lumen of the involved gut in most of the cases. This phenomenon occurred in eighteen cases in our series but is decidedly more common than these figures would indicate. The explanation of this phenomenon, as offered by Graves, is that the dilatation is due either to an early destruction of muscle fibres, with subsequent dilatation resulting from the accumulation of faeces, or to an early involvement of the submucous layer by the tumor which affects the plexus of nerves found in this layer. Frequently, there is an accompanying dilatation of the bowel proximal to the tumor which is due to a paralysis of the musculature by the invading growth.

Stenosis of the involved intestinal loop by the tumor is said by most writers to be less common than dilatation, however, in our series, there were thirty-seven cases with stenosis and only eighteen cases with dilatation. This disagreement between our figures and the accepted belief may be due to lack of complete pathological data in many of the cases. It does appear that dilatation of the intestinal lumen is more common than our figures would lead one to believe. Crowther found stenosis in only twenty-two of 191 cases of sarcoma of the intestine. Speese states that, although partial occlusion of the bowel is present in about one-half the cases, complete occlusion practically never develops from the presence of "sarcoma." He points out that even in large tumors encroaching upon the intestinal lumen a narrow passage can be demonstrated, a fact which explains the relative frequency of symptoms of chronic intermittent obstruction associated with this tumor. The occurrence of stenosis is dependent upon a fibrosis and contraction in the tumor which may develop late in the disease. Occasionally polypoid tumors may occlude or constrict the intestinal lumen, producing a stenosis, as occurred in the case reported by De Noyelles. In some instances, the stenosis of the bowel is due to the marked involvement of the mesenteric lymph-nodes which tend to aid in the compression of the lumen of the bowel. Lecene found only two instances of occlusion in a series of eighty-nine cases of sarcoma of the small intestine. This finding is in accord with the observation of Libman, Speese, Ewing, Rankin, and others who believe that occlusion in the course of lymphosarcoma is rare. However, a strikingly contradictory observation is recorded by Liu. In his series of twelve cases, stenosis of the intestinal lumen was present in ten cases of the annular type and in two cases of the polypoid type.

Intussusception is not an uncommon occurrence with lymphosarcoma of the intestines and is noted in sixteen cases. Kasemeyer collected 284 cases of intussusception of the intestines by tumors and found eighty-five (30 per cent) were caused by malignant growths, of which fifty-seven were carcinoma and twenty-six sarcoma. Speese collected fourteen cases of intussusception in a series of seventy-four cases operated upon for sarcoma of the

small intestine The condition is more common in the polypoid than in the annular type of tumor, probably owing to the fact that the annular type is accompanied by an aneurismal dilatation of the infiltrated intestinal walls which do not invaginate so readily In six of Liu's twelve cases, an intussusception had occurred They included each of the four polypoidal cases and two of the annular type Two are in children under ten years of age

The presence of another tumor of a different cell type in cases of lymphosarcoma is extremely rare Kriebig reports a case of lymphosarcoma of the ileum associated with an adenocarcinoma of the cæcum

*Histology*—The microscopical picture of this tumor is not always a consistent one, for it may show either a small round-cell or large round-cell lymphosarcoma Ewing has pointed out that these two forms may retain their separate identity, since they appear to arise from two specific types of cells (1) The reticulum cell of the germ centres of the follicle and of the pulp cord, and (2) the lymphocytes From the former type of cells there may develop a reticulum-cell sarcoma (large round-cell lymphosarcoma) and from the latter a malignant lymphocytoma Despite the fact that these two forms may develop under different clinical conditions and perhaps have different etiological factors, they must be classed under one heading, lymphosarcoma, until the exact nature of the relation of the lymphocyte to the reticulum cell is established

The cellular constituents of lymphosarcoma of the intestines may show some variation in size and shape, depending upon the rate of growth Usually they appear as large or medium-sized mononuclear cells whose nuclei are rather large and vesicular and contain one nucleolus The cytoplasm is present in fair quantity and is finely granular Occasionally, larger cells with two or three nuclei are present De Noyelles found that the predominating type of cell resembled the transitional mononuclear cell of the blood, mitotic figures are rather common Varying numbers of small lymphocytes, eosinophiles, and plasma-cells frequently accompany the tumor-cells, suggesting some resemblances to an infectious granuloma and so causing some misinterpretation or uncertainty in the diagnosis of the tumor

The stroma of the growth consists of a fine connective-tissue network which is sparse in some areas and in others is thickened with a tendency to fibrosis The cellular elements are irregularly interspersed in this meshwork A sclerosis and thickening of the gut wall may result from the stimulation of the fibro-elastic tissue and give rise to a scirrhus lymphoblastoma (lymphosarcoma), as noted by Graves The tumor appears to be vascular owing to the presence of many fine, thin-walled blood-vessels Some of these blood-vessels are compressed or occluded by the tumor-cells

The mucous membrane of the intestine shows some necrosis and desquamation of the epithelial cells The presence of a raw ulcer covered with débris is very common The muscular coats show a marked replacement of the muscular elements by the tumor-cells, with scattered areas of broken-down or atrophied muscle cells The serosa is intact and unaltered

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*Metastases and Adhesions to Other Organs*—Lymphosarcoma of the intestines is accompanied by metastases in some form or other in practically every case. While it is obvious that a distinction should be drawn between true metastases and adhesions, especially of the intra-abdominal organs, it is unfortunate that in many of the cases reviewed by us that there was either no mention made of such involvement or else no attempt to make such a pathological differentiation other than to include both conditions under the general term of metastasis.

The growth tends to spread early to lymph-nodes in the mesentery of the part of intestines involved. In our series, such involvement occurred in sixty-one cases, was absent in ten cases, and not mentioned in fifty-eight cases. In a series of forty-five autopsies, Lecene found thirty-four instances (75 per cent) of mesenteric involvement. The early and frequent involvement of the mesenteric lymph-glands may be quite extensive and often militates against a successful operative result which can be obtained only by a thorough removal of the mesentery of the affected bowel together with the tumor. Involvement of the superficial lymph-nodes and of those in the retro-peritoneal region and mediastinum is rarely noted. In our own case secondary abscess formation in the involved mesenteric lymph-nodes developed.

In the advanced cases, metastatic involvement of practically every abdominal organ has been found. The kidney, liver and spleen are the organs most frequently involved, the spread being hematogenous in nature. Metastases to other organs occurred in eighteen cases in our series. In this group of cases, the frequency with which the organs were involved is as follows: Kidney, 5, liver, 4, spleen, 4, omentum, 3, gall-bladder, 2, lung, 2, appendix, 1, ovary, 1, left axilla, 1, left elbow, 1, diaphragm, 1, parietal peritoneum, 1, transverse colon, 1. In one of the cases reported by Wortman, extensive metastases were found in the following structures: Kidney, liver, gall-bladder, diaphragm, and between the diaphragm and pericardium. Mackel found metastases in the kidney, spleen, gall-bladder, appendix, and omentum. Coley reported a case of lymphosarcoma of the small intestine in which an exploratory or laparotomy was performed for what was considered an inoperable tumor, the patient lived ten years. Metastases developed in the cervical region two years after operation, and in the left axilla and left elbow seven years after operation. These metastases responded well to intensive treatment with Coley's serum and radium, and the patient lived for ten years after the original operation. Molson found metastases in the kidney and also an ischio-rectal abscess. In an early but very interesting report not included in our series, Stutzberg cited a case of primary intestinal lymphosarcoma which showed a secondary diffuse infiltration of the meninges.

Involvement of adjacent viscera as a result of direct extension of the tumor to the peritoneal surface of these organs is rather commonly noted at operation or at autopsy. The bladder and uterus are occasionally involved as a result of the pelvic position of the tumor. Lecene studied the frequency of adhesions between the affected loop of bowel and other viscera and

reported intestinal adhesions in twelve cases and adhesions to the bladder in seven cases

Adhesions to intra-abdominal organs occurred in eighteen cases of our series. The character of the adhesions varied. In this group were Omentum, 4, mesentery, 3, large intestines, 3, abdominal walls (parietal peritoneum), 2, vagina, 2, uterus, 1, pelvic organs, 1, liver, 1, and small intestine, 1. In most instances, they were sharply localized and in others diffuse. The adhesions were mostly inflammatory in nature, but occasionally adherent to the tumor.

Speese states that there is a relation between the histological variety of the intestinal tumor and the metastases. He points out that the majority of recurrences and metastases occur in the lymphosarcoma or round-cell type of sarcoma, whereas spindle-cell sarcoma has a tendency to remain localized. His explanation is that the latter type (spindle-cell) is more frequently associated with stenosis of the intestinal lumen and consequently is accompanied by signs of acute intestinal obstruction which serve as an indication for an early operation before marked extension or metastases have had time to occur. Graves also points out that the so-called lymphoma, lymphosarcoma and small round-cell sarcoma tend to metastasize more often than the other forms of sarcoma.

*Blood Picture*—In practically all of the reported cases of this disease in which the blood findings are given, one notes an anæmia and a definite but moderate leucocytosis. The white blood count varies between 10,000 and 15,000 with a relative increase in the polymorphonuclear elements (70 to 85 per cent). None of the cases was accompanied by blood pictures associated with lymphatic leukemia. These findings would indicate that this disease is not a blood dyscrasia but rather a new growth.

*Differential Diagnosis*—The differential diagnosis in a case of lymphosarcoma of the intestines is very difficult and is often impossible without an operation. However, there are several interesting clinical and pathological features of lymphosarcoma that may serve to differentiate lymphosarcoma from carcinoma of the intestines. Lymphosarcoma is a rapidly progressive disease, whereas carcinoma has a slow course. The cachexia, anæmia, and wasting is more marked in lymphosarcoma. Intestinal hæmorrhage is decidedly less common in lymphosarcoma. Alternating constipation and frequent bloody stools occur in carcinoma. From a clinical standpoint, in patients with suspicious signs and symptoms, it is well to suspect lymphosarcoma when the patient is young (below fifteen years) and carcinoma when over forty years of age.

From a pathological standpoint, obstruction of the intestinal lumen is relatively uncommon in lymphosarcoma owing to the infrequent occurrence of complete occlusion of the intestine, whereas the majority of carcinoma cases show complete obstruction of the lumen. Patients with lymphosarcoma frequently develop a fatal toxæmia without signs of intestinal obstructions, despite the presence of a large tumor. This is explained by the diffuse

nature of the growth in lymphosarcoma. As this tumor spreads through the submucous layers of the intestines, it gives rise to a long, tubular, sausage-shaped or elongated pouch, constricted at each end. In this manner, lymphosarcoma does not encroach upon the lumen of the bowel sufficiently to obstruct, but is apt to cause dilatation that gives the affected bowel the appearance of an aneurismal pouch. However, in some cases of lymphosarcoma, the diffusion of the growth in the submucous layer may cause a polypoid formation in the shape of single or multiple small pedunculated growths, which may give rise to intussusception and secondary intestinal obstruction. True stenosis of the lumen in lymphosarcoma is rarely due to a cicatricial contraction such as occurs in carcinoma, but usually to the pressure of metastatic glands in the mesentery of the affected bowel. Lymphosarcoma is usually larger, less circumscribed and less freely movable than carcinoma.

Another valuable differential point is the fact that metastases and lymphatic involvement occur late in carcinoma. In practically every case of lymphosarcoma, the mesenteric lymph-nodes show malignant changes, whereas the glands in the mesentery, draining the involved gut in carcinoma, may be enlarged, but show no signs of malignancy. Miller points out that patients with lymphosarcoma of the mesentery without involvement of the intestines are usually free from intestinal and gastric disturbances. He also states that lymphosarcoma differs from the other forms of lymphomas by its characteristic local destructive lesion and the formation of true metastases in distant organs.

*Pre-operative Diagnosis and Indications for Operations*—It appears that the most probable pre-operative diagnosis in a case of lymphosarcoma of the intestine would be either an acute or chronic intestinal obstruction, inasmuch as practically every case is accompanied by some degree of obstruction or such conditions as intussusception, stenosis, or adhesions. A more positive diagnosis can be made in the face of an acute or chronic intestinal obstruction when there is a palpable tumor present of more than a few days' duration and a neoplasm is suspected.

To venture a more definite diagnosis than the presence of a neoplasm is extremely hazardous, in view of the multitude of conditions that may present a similar picture or one extremely difficult to differentiate from intestinal lymphosarcoma.

The pre-operative diagnosis is stated in ninety-one cases of our series. There were only two cases correctly diagnosed before operation without such technical aids as X-ray examinations or biopsies. (1) Weeden's (Case XIV) lymphosarcoma of the intestines in a man, thirty-five years old, who had undergone appendectomy five months previously, and (2) Cabot's acute intestinal obstruction and lymphosarcoma of the intestines. In the case reported by Guliani, a tentative diagnosis of lymphosarcoma of the intestines, or cyst of the mesentery, was made before operation. There were five cases in which the diagnosis of lymphosarcoma of the rectum was made

by biopsy Rankin and Chumley, two cases, Bensaude, Cain, and Horwitz, two cases, Stolz, Gunsett, and Obeiling, one case. In one of the two cases reported by Bensaude, Cain, and Horwitz, a diagnosis of malignant lymphoma was made from biopsy of the cervical lymph-node two years previous to the biopsy of the rectal lymphosarcoma.

There were seven cases in which X-ray examination rendered valuable assistance in detecting the presence of an intestinal neoplasm and establishing the latter as a tentative diagnosis before operation. The X-ray diagnosis in these cases were (1) Puccinelli—tumor in the small intestines not connected with stomach or colon, (2) Silver—partial obstruction of small bowel due to tumor, (3) Kelly—six areas of dilatation in the small intestines due to tumor, (4) Golob—complete obstruction near splenic flexure, (5) Friend—malignancy of hepatic flexure, (6) Goodman—malignancy of transverse colon, and (7) Weeden (Case IX)—obstruction at splenic flexure.

In the following group of thirty-five cases, the diagnosis was not conclusive in regard to the etiological factor, but sufficiently accurate to serve as a definite indication for operation.

(1) <i>Intestinal Obstruction</i>		(4) <i>Malignancy</i>	
(a) Acute	6	(a) Transverse colon	1
(b) Acute with intussusception	3	(b) Ileocecal	1
(c) Type not mentioned	3	(c) Jejunum	1
		(d) Bowel	1
		(e) Gastro-intestinal tract	1
		(f) Probably sarcoma	1
(2) <i>Intussusception</i>		(5) <i>Miscellaneous</i>	
(a) Intussusception with tumor	1	(a) Ileus	2
		(b) Acute abdominal condition	1
		(c) Perforative peritonitis	1
(3) <i>Tumor</i>			
(a) Abdominal	3		
(b) Intestinal	2		
(c) Cecal	1		
(d) Rectal	1		

The diagnosis was incorrect in a rather large group, as indicated in the forty-one cases listed below.

(1) <i>Appendicitis</i>		(3) <i>Biliary Diseases</i>	
(a) Acute	4	(a) Gall-bladder disease	1
(b) Acute with abscess	2	(b) Gall-stones	1
(c) Acute with perforation	1	(c) Catarrhal jaundice	1
(d) Acute with peritonitis	1	(d) Cirrhosis of liver	1
(e) Acute or with stereoræmia	1		
(f) Acute or with tuberculous peritonitis	1	(4) <i>Colitis</i>	
(g) Chronic	3	(a) Chronic ulcerative colitis	1
(h) Chronic and jejunal carcinoma	1	(b) Enterocolitis	1
		(c) Colitis	1
		(d) Dysentery	1
(2) <i>Tuberculosis</i>		(5) <i>Ulcer</i>	
(a) Mesenteric lymph-nodes	2	(a) Gastric	1
(b) Peritonitis	2	(b) Duodenal with perforation	1
(c) Ulcer	1		
(d) Ulcer with perforative appendicitis	2	(6) <i>Gynecological</i>	
(e) Cecum and colon	1	(a) Right salpingitis	1
(f) Stenosis producing obstruction	1	(b) Sarcoma of uterus	7

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(7) <i>Mesentery</i>		(b) Generalized dropsy	1
(a) Sarcoma	1	(c) Pancreatic insufficiency	1
(b) Cyst	1	(d) Duodenal stenosis below ampulla due	
(8) <i>Miscellaneous</i>		to stenosis	1
(a) Kidney tumor	1		

Many authors, including Libman, Jopson, and White, have stressed the frequency with which lymphosarcoma of the intestines has been diagnosed as acute appendicitis. In fact, Miller states that the diagnosis of acute appendicitis is made oftener than any other. Occasionally, a diagnosis of appendicular abscess with chronic intestinal obstruction is made, as occurred in one of the cases reported by Liu. Earlier contributors to the subject state that other intra-abdominal conditions with which this has been confused are retroperitoneal tumors, neoplasms of the bladder or prostate, carcinomatosis of the abdomen secondary to malignancy in the ovary, and gynecological conditions such as uterine myomata and ovarian cysts.

In cases of lymphosarcoma which are accompanied by icterus, carcinoma of the liver or head of the pancreas with intestinal involvement may be suspected. The presence of pressure symptoms such as ascites, œdema of the legs, or distention of the veins of the abdomen and thorax, may lead to confusion and an erroneous diagnosis of a retroperitoneal tumor. In the rare cases of perforation of the tumor mass, a diagnosis of peritonitis may be made with the primary cause unsuspected.

It is possible that X-ray examination in the early cases might reveal a lesion in the small intestines. In tumor studies of the large bowel, X-ray studies are of immense value. With the recent refinements of X-ray technique, studies should not be limited to the stomach or large bowel, as has been stressed by Rankin.

When the clinical picture suggests intestinal obstructions, the administration of contrast substances by mouth is not only unnecessary, but often a dangerous procedure. It is not an infrequent experience of surgeons and roentgenologists to note the transformation of an incomplete obstruction into a complete one, following the administration by mouth of opaque substances for X-ray diagnosis. However, in cases of suspected obstructions due to tumors in the large intestines, X-ray examination following the injection of opaque substances as an enema into the rectum is clearly indicated and of great value.

X-ray examination without the use of opaque media in cases of intestinal obstruction has been the subject of recent study by European investigators, including Schwartz, Assman, Haesslin, Weil, Bensaude and Grenaux, Klobel, and others, and by the following Americans: Case, Kalbfleisch, Meyer and Biams, Davis and Rabwin, and Ochsner and Gianger. Their studies show that the presence of distended loops of intestines filled with gas and fluid is strongly suggestive of intestinal obstruction. The diagnosis is confirmed by the appearance of fluid levels in the intestinal loops. The fluid levels can be demonstrated best when the patient is placed in



the upright position or when lying on the side if he is too weak to move. Positive findings have been observed as early as five and one-half hours after obstruction.

These signs are found not only in obstructions in the large bowel but also in cases in which the obstruction is in the small bowel and hence this procedure offers an invaluable aid in diagnosis of the latter type of cases which usually are the most difficult to diagnose. Case has stressed the importance of gaseous distention in obstructions of the loop of small bowel; the parallel course of the coils of the intestines and the serrated contour of the bowel are characteristic findings. Weil emphasized the importance of multiple fluid levels in obstructions of the small intestines since normally no air is contained within the jejunum.

As mentioned above X-ray examinations have proved to be helpful in establishing an accurate diagnosis of an intestinal tumor in the following cases: (a) Small intestine (Puccinelli, Silver and Kelly), and (b) large intestine (Golob, Friend, Goodman and Weeden).

Despite the fact that a complete study of the clinical picture and laboratory investigation reveals no typical findings characteristic of lymphosarcoma of the intestines especially in the cases in which no tumor mass is palpable the indications for operative interference should be the presence of symptoms of an acute or chronic intestinal obstruction. It is only by early (operative) treatment of this disease that good results can be obtained. No surgeon can afford to be too conservative in his treatment of cases of chronic intestinal obstruction in which the etiological factor is obscure or unexplained.

#### CASE REPORT

**CASE No 9591**—A S. white male thirty-three years old married Jewish butcher. Admitted to Sinai Hospital February 27, 1927, 9:30 P.M. *Complaint*—Pain over entire lower abdomen. *Family History*—Unimportant.

*Past History*—Has always been in good health except for measles as a child and frequent sore throats in adolescence, which necessitated a tonsillectomy six years ago. No history of syphilis or gonorrhea.

*Present Illness*—During the past six weeks has had several attacks of cramps especially pain in the lower abdomen below the level of the umbilicus. The pain did not radiate and has gradually increased in severity. Attacks of pain were not accompanied by nausea, vomiting, chills, fever, jaundice, hematemesis or melena; they lasted from one to two hours. There was no relation to meals or exercise. No history of trauma obtained. There has been a moderate degree of constipation during the present illness. There have been no symptoms referable to the cardio-respiratory, genito-urinary or neuro-muscular systems.

*Physical Examination*—The patient was well developed and well nourished and did not appear acutely ill or toxic. Temperature, pulse and respiration were normal on admission. Examination was negative except for the abdomen which was full, round and of good muscle tone. There were no evidences of fluid, hernia or masses. Liver, spleen and kidneys not palpable. There was some spasticity and rigidity of the lower right rectus muscle. Definite tenderness was elicited in the right lower quadrant especially over McBurney's point and to the left of the umbilicus. Intestinal patterns and peristaltic waves were not present.

*Laboratory Findings*—Urine negative. Hemoglobin 70 per cent, red blood-cell-

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4,700,000, leucocytes, 8,500, with 90 per cent polymorphonuclears *Pre-operative Diagnosis*—Subacute appendicitis

*Operation*—This was performed on the following morning, February 27, 1927 under ether anaesthesia. Through a McBurney incision, the caecum and appendix were delivered and the appendix removed by cautery. The ligated appendiceal stump was not inverted. In view of the fact that the appendix appeared to be practically normal in appearance, further exploration of the large and small bowel was made and an annular growth was discovered in the terminal portion of the ileum about twelve centimetres from the ileocecal valve. The tumor mass was three centimetres long and in the centre was a ring-like depression, causing a circular constriction, two centimetres in diameter, of the tumor mass and a stenosis of the intestinal lumen. The serosa over the mass was intact and indicated that the tumor had originated in the intestinal wall. The tumor was not adherent to any other intra-abdominal organ.

In the mesentery attached to this section of the bowel were found two large inflammatory masses in addition to several enlarged mesenteric lymph-nodes. The upper of the two inflammatory masses in the mesentery measured approximately eight centimetres in diameter, it was reddish and indurated in the periphery and soft in the centre. When incised, this mass emitted a thick, greenish, foul-smelling pus. A culture of the pus revealed colon bacilli and streptococci. The lower inflammatory mass was about four centimetres in diameter and showed less congestion and induration. Incision of this mass revealed a grayish necrotic material, presumably broken-down glands.

Approximately nine centimetres of ileum containing the tumor and a small portion of the adjoining mesentery were removed. The cut ends of the ileum were inverted and reinforced with mattress sutures and a lateral anastomosis between the cut portions of ileum was made in the usual manner. After its completion, the abscessed areas in the mesentery were then incised and drained with two cigarette iodoform drains. The abdominal incision was closed in layers in the usual manner.

*Course in the Hospital*—Excepting for a very slight temperature elevation (not exceeding 101° F) during the first four days after operation, the patient made an uneventful recovery and was discharged on the twenty-seventh day after operation (March 27 1927) with the wound entirely closed.

*Pathological Report*—The macroscopical specimen consisted of a piece of ileum measuring nine centimetres in length. The tumor was annular in shape with a central constricting zone. The walls were markedly thickened. The mucosa was intact and smooth. The growth was of soft consistency. When the tumor was cut in the long diameter of the intestine, the constricting zone was found to measure 2.5 centimetres in diameter and produced an almost complete stenosis of the bowel, the lumen admitting only one finger. The mucosa was smooth and showed no areas of ulcerations.

At one end of the slide glands of the type that are found in the small intestines, together with normal mucosa, submucosa and muscularis were noted. As we moved along, the mucosa was elevated and the glands distorted. The elevation of the mucosa was due to the active growth and proliferation of the lymphoid tissue of the submucosa. In some areas, very little remained of the mucosa. There was a marked invasion and replacement of the muscularis by the lymphoid tissue and some extension of the tumor into the mucosa.

The tumor was composed of tissue closely resembling lymphoid glands excepting that an absence of germinal centres was noted. The cellular morphology varied somewhat, but the majority of the cells were of the large mononuclear type. Little or no endothelial hyperplasia were found. There were no cells of the Dorothy Reed type. The tumor obviously arose from the lymphoid tissue of the submucosa. None of the mesenteric lymph-nodes were obtained for microscopical study. *Diagnosis*—Lymphosarcoma of ileum.

*Note*—This diagnosis was confirmed by Drs L. Sachs and S. Cone, pathologists at Sinai Hospital. Dr S. McCleary, pathologist at Mercy Hospital, considered the

tumor a lymphoblastoma Dr J C Bloodgood examined sections of this tumor and called it a chronic inflammatory tumor or sarcoma and compared this tumor to those studied by Liu in his laboratory

*Subsequent Course*—Deep X-ray therapy was advised and urged upon discharge from the hospital but the patient refused to cooperate He remained in apparently excellent health for four months after the operation, but then began to complain of abdominal pain and distress and presented signs of recurrence of growth He gradually became weaker and died of a recurrence of the growth six months after operation

*Treatment*—Whatever success is associated with the treatment of lymphosarcoma of the intestines is directly dependent upon an early diagnosis and the institution of prompt treatment The rapidity of growth and the marked invasive and metastatic tendencies of this tumor are responsible for the usual unsatisfactory results It appears that in cases in which the tumor is more or less localized and the lymphatic involvement is not too extensive surgery in the form of resection of involved gut offers the best results from a curative or palliative standpoint If the growth is so extensive as to make a resection impractical or an extreme risk a palliative procedure such as a side-tracking operation (entero-enterostomy, ileocolostomy, ileosigmoidostomy) or drawing a loop of bowel to the outside to make an artificial anus (colostomy, etc) is indicated The last-mentioned operative procedure is particularly adaptable to extensive tumors with an accompanying stenosis Should inspection reveal an extensive infiltrating growth with metastases it is the better part of discretion and valor to close the abdomen without further manipulation

Since a large percentage of the cases are complicated by an intussusception or stenosis the indication for operation almost always lies in an intestinal obstruction of the acute or chronic type The choice of the operative measure to be carried out can be decided only at the operating table but should always aim to relieve immediate and urgent symptoms and if possible, to effect a probable cure by a thorough resection of the involved gut One cannot stress too much the fact that delay in instituting treatment militates against a good operative result Rankin feels that the end-results of the surgical treatment of this condition from the standpoint of prolonging life are rather poor He is opposed to surgery other than a palliative procedure, excepting in those cases in which an early diagnosis has been made It appears however that the best results in the treatment of lymphosarcoma are obtained by a radical excision of the tumor mass at the earliest possible date followed by irradiation

Minot and Isaacs state that irradiation of this type of tumor is beneficial because it alleviates the symptoms and decreases the size of the lesions They point out that irradiation improves the patient's general condition and efficiency but apparently does not influence the duration of the disease Desjardins and Ford are of the opinion that while radiation may or may not cause definite prolongation of life, it does keep the disease under complete or partial control for varying lengths of time It is a well-known fact that malignant lymph-nodes of the abdominal cavity respond very poorly to Rontgen-ray treatment When radiation is used as a palliative or post-operative pre-

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ventive measure, it is frequently followed by nausea, vomiting, or severe gastro-intestinal disturbances, and hence must be carefully controlled

The use of radium has been advocated in the treatment of lymphosarcoma of the intestines as a result of its success in the treatment of carcomatous and lymphosarcomatous conditions in other parts of the body. Bloodgood maintains that radium affords a surer means of effecting a cure in lymphosarcoma than surgery. The difficulties of making an accurate pre-operative diagnosis and the inaccessibility of lymphosarcoma of the intestines to radium applications other than through an abdominal incision would tend to offset its value in this particular affliction. However, we feel that radium as a palliative measure should be used in the inoperable cases wherever possible.

The internal use of arsenic and other metallic salts was once in great vogue in the treatment of lymphosarcoma of the intestines, as evidenced by its frequent use among the earlier writers on the subject. Large doses were given over long periods of time and transient or temporary improvement was reported in some instances. The results of such medication have never been satisfactory and its use has been discarded. In our series, arsenic in the form of salvarsan was employed in conjunction with operation and radiation in only one case (Zimmer).

The type of treatment used in the series of 126 cases collected by the authors was predominantly surgical. In 103 cases, operative treatment in the form of intestinal anastomosis, with or without radical removal of the tumor segment and gland-bearing area, was carried out. These groups are reported in greater detail later. Radiation was employed in twenty-eight cases as a post-operative measure to prevent recurrence in twenty cases, as a palliative procedure as soon as the diagnosis of an inoperable tumor was established by an exploratory laparotomy in two cases, after a diagnosis had been made by biopsy in four cases, before operation in one case, and in one patient was not operated upon. Coley's serum was used in two cases with good results. In Coley's case it was combined with radium, and in Battle's case, it was after the third operation in a patient who was submitted to five operations. Radium was used in three cases, in two cases (Coley's and De Noyelles') as a palliative procedure supplementing operation, and in one case (Rankin and Chumley) for curative purposes after a diagnosis of rectal lymphosarcoma has been made by proctoscopical examination and biopsy. In eleven cases, an exploratory laparotomy was performed and an inoperable tumor was found. One of these patients (Loria) had a generalized peritonitis also and drainage was instituted.

### THE OPERATIVE TREATMENT OF LYMPHOSARCOMA OF THE INTESTINES

Operation was performed in 114 cases in our series, eleven were exploratory laparotomies (Wortman, Lotter, Macked, Carlo, Beer, Loria and Wedden—five cases). In the remaining 103 cases a palliative or side-tracking operation was performed in eight instances and a resection and an anas-

tomosis in seventy-four cases In addition, there were eleven cases in which more than one operation was performed at different intervals of time There were ten cases in which the type of operation performed was not mentioned

TABLE I

*Resection Plus Anastomosis Group*

(a) Lateral anastomosis of small intestine	5
(b) End-to-end anastomosis of small intestine	22
(c) End-to-end anastomosis of small and large intestine	1
(d) End-to-end side of large and small intestine	1
(e) Gastroenterostomy	2
(f) Ileocolostomy	9
(g) Colostomy	3
(h) Double resection of small intestine and anastomosis (puccinelli)	1
(i) Double resection with lateral anastomosis of jejunum and end-to-end of large intestine (Fannesci)	1
(j) Triple resection type of anastomosis not mentioned	28
<i>Total</i>	74

*Palliative Operations*

(a) Appendectomy	2
(b) Closure of perforation	1
(c) First-stage Mikulicz	1
(d) First-stage Mikulicz plus cæcostomy	1
(e) First-stage Mikulicz plus cæcostomy and appendectomy (Golob)	1
(f) Lateral anastomosis of small intestine and lateral anastomosis of large intestine (Fannuci)	1
(g) End-to-end anastomosis of small intestine plus lateral ileocolostomy	1
<i>Total</i>	8

TABLE II

*Cases in Which More Than One Operation was Performed at Different Time Intervals*

Author	First Operation	Second Operation	Intervals of Time
Fisher	Exclusion of tumor plus ileocolostomy	Radical resection	Not mentioned
Perry	Side-to-side anastomosis	Enterostomy for adhesions	1 week
Fullerton	Resection plus end-to-end anastomosis	Resection plus end-to-end anastomosis for pain and mass	42 days
Simoncelli	Resection plus end-to-end anastomosis	Resection plus end-to-end anastomosis	1 year
Pissarewa	Reduction of intussusception	Reduction of intussusception (too weak for resection)	3 weeks
Friend	Appendectomy	Operation for partial obstruction (type)	2 weeks
Hagyard	Appendectomy and cæcectomy	Ileocolostomy and Mikulicz	Not mentioned
Weeden	Entero-anastomosis	Resection	26 days
Liu	Resection anastomosis and reduction of intussusception	Exploratory laparotomy (growth inoperable)	Not mentioned

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TABLE II—(Continued)

Author	First Operation	Second Operation	Intervals of Time
Battle (5 operations)	Intussusception reduced	(a) Intussusception reduced plus lateral anastomosis (b) Removal of growth and end-to-end anastomosis (c) Exploratory laparotomy (d) Resection of recurrent tumor plus lateral anastomosis	Over a period of 3 years
Koch (4 operations)	Suture of ulcer plus entero-anastomosis to exclude ulcer portion of intestines	(a) Resection of 18 meters of ileum with end-to-end anastomosis (b) Release of adhesions (c) Release of adhesions with side-to-side anastomosis	Not mentioned

The amount of gut resected is mentioned in forty-four cases of our series. In each instance, the tumor-bearing segment was resected, and in three instances, it was necessary to perform an additional resection of adjacent loops or portions of intestines involved by adhesions or extension of tumor (Fannucci and Puccinelli) or intussusceptions (Liu, Case VII). The following table indicates the exact amount of intestines resected in each case.

TABLE III

## Amount of Intestine Removed

<i>Small Intestines</i>			
12 cm jejunum	Weeden (Case VII)	40 cm small intestines	Graef
12 cm jejunum	Valdo	40 cm small intestines	Puccinelli
25 cm jejunum	Puccinelli	45 cm small intestines	Mirotworzew and Sacharow
35 cm jejunum	Brun	45 cm small intestines	E M Fisher
35 cm jejunum and 1 year later	Simoncelli	50 cm small intestines	Kricke
14 cm small intestine	Simoncelli	50 cm small intestines	Miller
9 cm ileum	Authors' case	60 cm small intestines	Perez
20 cm ileum	Guhani	75 cm small intestines	
40 cm ileum	De Noyelles	145 m small intestines (Double resection)	Puccinelli
50 cm ileum	Simoncelli	15 m small intestines	Puccinelli
50 cm ileum	Rankin	152 m small intestines	Kelly
60 cm ileum	Liu (Case V)		
70 cm ileum	Silver	<i>Large Intestines</i>	
80 cm ileum	Puccinelli	15 cm sigmoid	Goodman
92 cm ileum	W H Fisher	14 cm rectum	Brun
16 cm ileum	Puccinelli		
Triple resection (amt)	Liu (Case VII)	<i>Small and Large Intestines</i>	
Tumor segment (amt)	Fullerton	10 cm ileum plus cæcum	Liu (Case XI)
		10 cm ileum plus cæcum	Graham
8 cm small intestines	Bendetti, Valentine	34 cm ileum plus cæcum plus 25 cm of ascending colon	Kriebig
14 cm small intestines	Douglas	20 cm duodenum plus cæcum plus ascending colon	Rankin
30 cm small intestines	Wortman		
35 cm small intestines	Peterson		

<i>Small and Large Intestines (cont'd)</i>		Ileum plus cæcum	Liu (Case X)
5 cm ileum plus cæcum plus ascending colon plus 10 cm of transverse colon	Perry	Ileum plus cæcum plus ascending colon	Liu (Case LX)
5 cm jejunum plus two- thirds of sigmoid plus distal part of descending colon (double resection)	Fannetti	Terminal ileum plus cæcum plus ascending colon plus hepatic flexure	Thomson
		Ileocecal mass	Condat

The question of resection of the various portions of the intestinal canal in the operative treatment of this condition is of extreme importance to the surgeon. Experiments on animals and series of human cases have proved that the whole or any portion of the large intestine may be removed without jeopardizing life. On the other hand, the removal of large amounts of small intestine has a more serious aspect as affecting the condition of the patient.

In 1912, Flint collected reports of fifty-nine cases of extensive resection of the small intestine with forty-eight recoveries. Speese (1914) found over fifty-four cases with fifty-three recoveries. Watson (1923) was able to find seventy-two recorded cases of extensive resection of the small intestine. Jerauld and Washburn (1929) studied the reported cases of extensive resection of the small intestine (more than 200 centimetres, or six feet seven inches) and state that the total number of such cases recorded to date is well under 100.

Many of the cases of extensive resections reviewed by the authors were attended by relatively good results and are worthy of further mention. Perez resected seventy-five centimetres of the small intestine in a male, aged thirty-seven years, who was reported as being in excellent health seven years after operation. T. H. Kelly resected about five feet (152 centimetres) of small intestine, beginning at the duodenum, in a female patient, aged thirty-four years, who was alive and well nine months after operation. Puccinelli reported three cases with resections of more than one metre: (1) Male, forty-six years old, had 16 metres of ileum removed and lived for three years with no recurrence; (2) male, thirty-one years old, had 15 metres of small intestine resected and lived for three months, but had a recurrence of the growth; (3) male, twenty-six years old, was subjected to a double resection of the small intestine with the removal of 145 metres of gut and lived for fourteen days, death resulting from intestinal hemorrhage. Perry's patient was alive and well five and one-half years after a resection of five centimetres of the terminal ileum, the entire cæcum and ascending colon, and ten centimetres of the transverse colon. One of the patients operated upon by Rankin had twenty centimetres terminal ileum, cæcum and ascending colon resected, and made an uneventful recovery, but died four months after operation from recurrence. Kriebig and Weeden (Case XI) reported cases living and well one year after resection of the terminal ileum, cæcum, and ascending colon. Thomson's patient, male, aged fifty years, lived seven years, nine months, after resection of the terminal ileum, cæcum, ascending colon, and hepatic flexure, dying of pneumonia, notwithstanding the fact that he had recurrence in rectum and mediastinum two years after operation which responded well to deep X-ray treatment.

The immediate mortality in these cases of extensive resection was very low. The only patient dying within twenty-four hours of operation was reported by Fannetti. His patient was subjected to a double resection: (1) Five centimetres jejunum, and (2) two-thirds of the sigmoid plus the distal portion of the descending colon, and died of

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cardiorenal insufficiency Liu's patient (Case VII) had a triple resection of the small intestine, but died on the fourteenth day after operation of a pulmonary embolus

Treves examined 100 bodies and found the average length of the small intestines in the male to be twenty-two feet, five inches, and in the female, twenty-three feet, five inches The shortest small intestine was fifteen feet, six inches, and longest, thirty-one feet Thus a resection of 200 centimetres (six feet, seven inches) may almost equal one-half the length of the small intestine, but usually is equivalent to about one-third of the total length

Flint studied the effect of resection of varying amounts of the small intestine in dogs and found that resection of as much as 50 per cent of the total intestine may be accomplished without fatal results A gradual return to a practically normal condition as regards weight and metabolism follows such a resection, if the animal is maintained on favorable diets after operation Resection of 75 per cent or more of the small intestine may be survived but the animals do not return to normal weight, even after the establishment of a good compensatory process Flint found that the compensatory process following resections of the small intestine consists of a hypertrophy and a hyperplasia of the remaining portion of the small intestine, but with no regeneration of the villi and crypts

Speese pointed out that human patients behave, in general, like animals, in showing similar metabolic disturbances Jerauld and Washburn are of the opinion that 200 centimetres is the limit of resection, and that beyond this serious metabolic disturbances may result They found that some persons are apparently not affected by a resection of one-third of the small intestine, but that others have a diarrhoea They advocate a diet rich in carbohydrates and nitrogenous substances and poor in fat for patients in whom an extensive resection has been done In these cases, death results from decompensation due to improper diet after many years of apparently good health

The degree of digestive and metabolic disturbance appears to be greater following resections of the small intestine, than of the large intestine Likewise, the removal of the proximal portion of small intestine is attended by more serious consequences than the removal of the distal portion Furthermore, it has been definitely shown that neither the stomach nor the colon are able to compensate for the loss of large portions of the small intestines It is of paramount importance for the surgeon to resect the minimal amount of intestine consistent with the pathological changes present, and to leave an amount of small intestines sufficient for compensatory purposes in order to forestall the development of digestive disturbances and inanition

It is interesting to note that successful resections of over 400 centimetres of the small intestines are on record In 1923, Doerfler reported the largest successful resection which was done for volvulus of the entire bowel of thirty hours' duration After resection of the gangrenous bowel, there remained twelve centimetres (four and three-quarter inches) of the upper segment at the duodeno-jejunal flexure and twenty centimetres (eight inches) of the lower segment at the cæcum These segments were joined by a side-to-side anastomosis and the reconstructed portion measured only twenty-four centimetres (9 1/2 inches) His patient was fifty-eight years of age, and was in perfect health six years after operation

Jerauld and Washburn report a case in a man of thirty-six years, in which nineteen feet (570 centimetres) of gangrenous intestine (approximately two-thirds of the small bowel) had been successfully resected The patient survived a second operation for in-



testinal obstruction and was alive and well two and one-half years after operation. Brenner (quoted by Denk) resected 540 centimetres (seventeen feet, nine inches) of gangrenous small intestine for a strangulated hernia in a female of sixty-one years. The patient made a good recovery, but died of marasmus two and one-half years after operation. In 1907, Storp reported the successful resection of 510 centimetres (sixteen feet, nine inches) of small intestine, including all of the ileum and part of the jejunum for a sarcoma of the mesentery in a male aged twenty-one years. The patient made an excellent recovery and gained weight, but unfortunately died five months after operation, from a recurrence of the sarcoma.

*Prognosis*—The earlier writers on the subject of lymphosarcoma, or sarcoma of the intestines, particularly Baltzer and Libman, assume a very pessimistic attitude in regard to the prognosis, inasmuch as they believed that the condition was invariably and rapidly fatal. This is, of course, true for the untreated cases, but a more optimistic view can be taken in the treated cases, especially those operated on early in the course of the disease. Treatment in the form of surgery may not offer a permanent cure, but it has served to prolong life several months or years, especially when combined with irradiation. In the literature of the past few years, one notes frequent reports of patients who have lived from one to eight years after operation with no recurrences of the growth.

Speese collected seventy-four cases of resection of the small intestine for "sarcoma." In this series, there were fifty-five recoveries, nineteen deaths following operation, and nine recurrences at varying periods (three months to fifteen months). His figures are very interesting and are quoted in full.

Number of patients dying within twenty-four hours after operation	10
Number of patients dying within one week after operation	11
Number of patients dying within one year after operation	12 (cause of one death was metastases)
Number of patients showing no recurrence	21
After 3 months	2
After 4 months	1
After 5 months	1
After 6 months	2
After 7 months	1
After 8 months	1
After 9 months	1
After 10 months	2
After 12 months	1
After 16 months	1
After 18 months	1
After 27 months	1
After 3 years	2
After 4 years	2
After 8 years	1
After several years	1

In twenty-three cases, no subsequent history was obtained.

However, the recent advances in operative technic and the greater attention to post-operative care have brought about a reduction in operative mortality with increased prolongation of life.

A study of the mortality and morbidity in the 103 operative cases in our series disclosed some interesting information. In eighty-five cases, the length of life after operation was definitely stated, in nine cases, operative recovery occurred, but no mention was made of the duration of life after operation,

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and in nine cases, no history was obtained of an operative recovery or of the length of life after operation

In the former group (eighty-five cases), nine died within twenty-four hours after operation, and six within forty-eight hours, giving an immediate operative mortality of 17.6 per cent, fifteen (17.6 per cent) died within the first year after operation, and thirty (35.2 per cent) lived more than a year. Twenty-five (29.4 per cent) died within the first year after operation.

Further analysis of the thirty patients who lived more than one year showed

(a)	9	alive from	1 to	2 years after operation
(b)	4	alive from	2 to	3 years after operation
(c)	5	alive from	3 to	4 years after operation
(d)	None	alive from	4 to	5 years after operation
(e)	4	alive from	5 to	6 years after operation
(f)	None	alive from	6 to	7 years after operation
(g)	5	alive from	7 to	8 years after operation
(h)	1	alive from	8 to	9 years after operation
(i)	None	alive from	9 to	10 years after operation
(j)	1	alive from	10 to	11 years after operation
(k)	1	alive from	11 to	years after operation

The average duration of life for the group of eighty-five operated cases was 569.4 days, or approximately nineteen months.

Recurrence after operation occurred in twenty cases, which is seemingly a low figure and is explained by the fact that in many of the case reports the necessary data were lacking. The time of recurrence was stated in eleven cases as follows:

After 1 month	3
After 2 months	1
After 3 months	1
After 4 months	2
After 6 months	1
After 10 months	1
After 2 years	1

In one case (Simoncelli) recurrence was noted four months after the first operation and two months after the second operation. There were ten patients alive and well five years or more after operation, with no evident signs of recurrence.

5 years	3 cases (Gerster, Douglas, Liu—Case XII)	"
5½ years	1 case (Perry)	"
7 years	3 cases (Battle, Perez, Liu—Case X)	"
7 years 9 months	1 case (Thomson)	"
8½ years	1 case (Liu—Case VIII)	"
11 years	1 case (Moir, Walker)	"

The cause of death is mentioned in one non-operative case and in twenty-four operative cases. The non-operative case (Clopton) died of bronchopneumonia. The cause of death in the twenty-four operative cases was as follows:

(1) Generalized lymphosarcomatosis	Guliani, Wortman
(2) Recurrence of metastasis	Valdes, Simoncelli, Rankin, and Chumley (2 cases)
(3) Exacerbation of growth with hæmaturia and thrombosis of both legs	Lehmkuhl
(4) General peritonitis	Golob, Koch, Pissarewa
(5) General peritonitis with strangulated hernia	Cabot
(6) General peritonitis and pleurisy	Friend
(7) Hæmorrhage from the bowel	Fisher, Puccinelli
(8) Shock	Miller
(9) Bronchopneumonia	Rankin
(10) Bronchopneumonia and pulmonary abscess	Puccinelli
(11) Pulmonary embolism	Liu
(12) General asthenia	Goodman, Hneider
(13) Cachexia	Carlos, Bensaude, Cam and Horwitz
(14) Cachexia and vomiting	Wortman
(15) Cardiorenal insufficiency	Fannucci

The most frequent cause of death occurring within a short time after operation is a general peritonitis. In the patients dying some time (months or years) after operation, recurrence or metastasis is responsible for the death.

In the series of twelve operative cases reported by Liu, there was one operative death. Four patients were living and free of recurrence from one and one-half to six years after operation, and only two patients died of recurrence between two and three months after operation. Miller cited patients living two to eight years after operation. In Rankin and Chumley's series of fifteen operative cases, treated by resection and receiving radiation after operation, five died of recurrence. Four of these died with an average life period of four and one-half months, and one was living at the time of report but had a recurrence. Two of the five that died had a generalized form of recurrence. Thomson reported the case of one patient with lymphosarcoma of the ileocecal coil treated by extensive resection, who developed a recurrence in the form of rectal and mediastinal lymphosarcoma two years after operation, which responded well to deep X-ray treatment. Simoncelli reported a case of lymphosarcoma of the jejunum with recurrence four months after operation. A year after the first operation, a second operation was performed with another recurrence two months later. The patient died one year and five months after the first operation.

#### CONCLUSIONS

The authors have collected 125 cases of lymphosarcoma of the small and large intestines in addition to the case herewith reported, making a total of 375 cases to date. The majority of the cases in our series have been reported since the publication of Graves' article in 1919, while several of the cases antedate, but were not included in, Graves' series. A statistical study of the clinical and pathological data in the 126 cases collected by the authors warrants the following conclusions:

~ (1) Lymphosarcoma occurs more frequently in the small than in the large intestines, the ratio being approximately 2 to 1. The most common

location in the intestinal tract is the ileum. The cæcum, jejunum, and rectum, respectively, follow in order of frequency.

(2) The tumor is found most frequently in the first, third, and fourth decades of life. The average age incidence in the authors' series was 33.19 years.

(3) Males show a greater predisposition for the disease than females in the ratio of 5 to 2.

(4) The tumor occurs most frequently in the white race, but occasionally is noted in Negroes.

(5) The etiology of the tumor remains obscure. The rôle of trauma, antecedent or intercurrent disease, and inflammation or irritation of a chemical or bacterial nature in the production of this tumor has not been definitely established.

(6) The disease is not accompanied by a characteristic clinical syndrome. In most cases, the predominant symptoms are those of an acute or chronic intestinal obstruction. A correct pre-operative diagnosis is seldom made because of the extreme difficulty in differentiating this condition from other intra-abdominal diseases.

(7) Lymphosarcoma in the intestines may appear as an annular or polypoid growth. The former is the more common form. The tumor begins in the lymphoid tissue of the submucosa and spreads laterally through the coats of the intestines. It gradually invades and destroys the muscular coats to appear as a subserous tumor of rather firm consistence. The tumor rarely penetrates the serosa, but frequently causes an ulceration of the mucosa covering the tumor.

(8) It is almost the universal opinion that there is a decided tendency to aneurismal dilatation of the lumen of the involved gut in most cases, and that stenosis of the involved intestinal segment is less common than dilatation. In our series, the incidence of these pathological phenomena was reversed, as indicated by the thirty-seven cases with stenosis and eighteen with dilatation. We feel that these figures do not express the true relative incidence of these pathological findings, since they are based on less than half the cases in our series. The variance may be explained by the fact that in the majority of cases complete pathological data were lacking.

(9) Intussusception occasionally may be associated with lymphosarcoma of the intestines, especially with the polypoid type of tumor.

(10) Lymphosarcoma of the intestines is accompanied by metastases in some form or other, in practically every case. In the majority of cases, involvement of the mesenteric nodes of the affected intestinal segment by way of the lymphatics occurs. In a smaller number of cases, metastases occur in other parts of the body, especially the kidneys, liver, spleen, and ovaries by way of the blood-stream.

(11) Adhesions of the tumor mass to other intra-abdominal organs is a relatively frequent occurrence, secondary abscess formation of the lymph-

nodes in the mesentery of the involved gut, such as occurred in our own case, is rare )

(12) The proper treatment of lymphosarcoma of the intestines is directly dependent upon an early diagnosis and the institution of prompt surgical measures

(13) From a curative standpoint, surgery in the form of a radical resection of the involved gut and its mesentery offers the most, especially when the tumor is localized, and the lymphatic involvement is not too extensive. From a palliative standpoint, a side-tracking operation is indicated, especially when the growth is so extensive as to render a resection impractical or an extreme risk

(14) Radiation should be employed in every case, in the inoperable cases, to control the growth of the tumor and to prolong life, and in the operable cases, to prevent recurrences and metastases

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# COMPLICATIONS ASSOCIATED WITH MAJOR PROCTECTOMY\*

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MY PURPOSE in discussing this subject of complications associated with radical operations for carcinoma of the rectum, is to analyze the hazards that may be expected to occur in these operations when done in a general surgical service, and to emphasize the advantages of limiting these operations to members of the staff experienced in this type of surgery

In reviewing the literature of the past ten years on this subject of surgery of carcinoma of the rectum, one is immediately impressed by the fact that major emphasis is placed upon the operative mortality and the late results in these operations. This is quite as it should be, for these are the two outstanding considerations, for on the one hand there is a marked difference in the mortality rate of the several procedures, and a distinct difference in the life expectancy, if one combines the figures of the most experienced surgeons reporting their results. I have been disappointed in reading these reports, to find how meagre is the discussion and analysis of the complications of these operations, which, of course contribute so definitely either to the mortality or to the prolonged convalescence of these procedures.

Thus, in the symposium on cancer of the rectum reported in the British Medical Journal in 1920,<sup>1</sup> are included Miles' great contribution and full discussion by Grey-Turner, Lockhardt-Mummery, Gordon-Watson, and Uilkie, all authorities in this field. But in none of these discussions is there any analysis of the complications. The same is true of the latest papers by Miles,<sup>2</sup> by Jones,<sup>3</sup> by Rankin,<sup>4</sup> by Coffey,<sup>5</sup> and by Schmieden<sup>6</sup> that have appeared since 1927.

During the past seventeen years, the period of our follow-up system at the Presbyterian Hospital, we have had two hundred patients admitted with a proven diagnosis of carcinoma of the rectum. The analysis of this series especially with regard to the operability, the type of operation, the technique used by several of the surgeons, and the late follow-up results with the various procedures, is too large a subject to discuss in a short paper.

In 1925 we organized our Proctology Clinic under Doctor Janssen's supervision, along lines conducive to the accurate study of rectal disease, especially neoplastic and since then the study of the pathological material and the operative results have steadily improved, so that at present the rationale and procedures in these cases are far better understood and carried out than

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during the preceding ten-year period. But the study of the complications covers the seventeen-year period and includes both private and ward cases.

A study of the various complications listed under the several procedures brings out strikingly the differences in morbidity in major operations on this part of the intestinal tract, as compared with those on the stomach and duodenum, biliary tract and spleen, notably in the high incidence of urological complications and the low incidence of associated pulmonary disasters. This outstanding difference is limited to the cases where the operations have been carried into the pelvis. This will be discussed in more detail, both as to etiology and therapy. The other three major complications, ileus, hæmorrhage and sepsis, will be considered at greater length than the other less frequent and scattered complications.

Infection of the urinary tract and its immediate and late sequelæ may be considered the most common complication. If urine cultures and microscopical sediment examinations are used as the criteria—and no doubt they are the only accurate tests—the incidence of cystitis would be more nearly 100 per cent in the radical operations. We have based our incidence on the presence of pus in the urinalysis reports and the need for treatment of cystitis or associated urinary complications.

The only accurate studies on the incidence of urinary infection associated with proctectomy that I have been able to find are those of Cuthbert Dukes,<sup>7</sup> of St Mark's Hospital, London. In a series of fifty cases, accurate daily microscopical studies of the urine were made during the post-operative course in the hospital. These examinations, quantitative in character, based upon the standard of 0–10 leucocytes normal, 10–100 excessive, 100 plus leucocytes in clumps indicating pus, brought out the disconcerting fact that a cystitis developed within a few days of the proctectomy in all fourteen female patients, and in the first fourteen males where an indwelling catheter was used with a wooden stopper. A modified catheterization method with antiseptic irrigation reduced this incidence in males from 100 per cent to 60 per cent. The following sequence of events occurred in every one of the first twenty-eight cases. All were catheterized. The urine remained sterile until the second or third day, when staphylococci appeared in cultures. During the first five days the urine cell count showed either an excess of leucocytes or else a trace of pus, and then, rather abruptly, from the sixth to the eighth day after operation pus became abundant, the cell count rising from 100 to 1,000 or over, per cubic centimetre. Pyuria usually persisted for the remainder of the patient's stay in the hospital (five to eight weeks) but in some cases it subsided within four weeks.

In our cases of radical operation, frank urological complications occurred in half of the cases. In the fifty abdomino-perineal operations, nine patients died before cystitis could be noted. In twelve there was no evidence of cystitis nor any record of a catheter being used. In five patients three males and two females catheterization was not followed by cystitis. In the remain-

ing twenty-four cases, all catheterized, cystitis was a definite complication, requiring treatment. Our observation regarding the time of onset of cystitis after catheterization corresponds with Dukes' statement.

In the discussion as to the cause of these bladder infections, Doctor Dukes and Mr. Lockhart-Mummery,<sup>7</sup> who commented on his paper, attribute the cystitis to the introduction of bacteria along the catheter into a traumatized bladder containing residual urine, and a bladder whose normal supports have been largely removed. There is another factor not mentioned by any of the surgeons discussing this subject, save Daniel F. Jones,<sup>8</sup> who suggests it as a possibility—and that is the complete destruction of the nerve supply to the bladder. According to all the recognized authorities such as Quain, Testut and Jacobs, and Spalteholz, the nerve supply is as follows:

The visceral branches of the fourth sacral nerve are directed forwards to the lower part of the bladder, and communicate freely with branches from the sympathetic nerve. These branches are associated with others proceeding from the third sacral nerve, and they are sometimes derived mainly from the latter nerve. Sometimes filaments are added from the second sacral nerve.

The lumbar sympathetic motor fibres to the bladder pass by the aortic plexus to the inferior mesenteric ganglion, and thence through the hypogastric and pelvic plexuses, to supply the circular muscle, including the sphincter. Associated with these there are probably inhibitory fibres of the longitudinal muscle.

*Pelvic plexus*—The pelvic or inferior hypogastric plexuses, one on each side, are placed in the lower part of the pelvic cavity by the side of the rectum, and of the vagina in the female. The nerves, continued from the hypogastric plexus, enter into repeated communications as they descend, and form at the points of connection small knots, which contain a little ganglionic matter. After descending some way, they become united with branches of the spinal nerves, as well as with a few offsets of the sacral ganglia, and the union of all constitutes the pelvic plexus.

From the plexus so constituted, numerous nerves are distributed to the pelvic viscera. They correspond in great measure with the branches of the internal iliac artery, and vary with the sex, thus, besides hæmorrhoidal and vesical nerves, which are common to both sexes, there are nerves special to each—namely, in the male for the prostate, vesicula seminalis, and vas deferens, in the female for the vagina, uterus, ovary, and Fallopian tube.

The nerves distributed to the urinary bladder and the vagina contain a larger proportion of spinal fibres than those furnished to the other pelvic viscera.

*Vesical plexus*—The nerves of the urinary bladder are very numerous. They are directed from the lower part of the pelvic plexus to the side and lower part of the bladder. At first these nerves accompany the vesical blood-vessels, but afterwards they leave the vessels and subdivide into minute branches before perforating the muscular coat of the organ. The lower part

of the ureter is also supplied by these nerves, and secondary plexuses are given in the male to the vas deferens and the vesicula seminalis

It is evident from the photograph of the dissection of the nerve supply taken from Spalteholz<sup>9</sup> that in the blind and blunt dissection of the rectum in the pelvis, and in its separation from the bladder, prostate, and seminal vesicles, and from the uterus and vagina in the female, the nerve supply as distributed by the pelvic plexus to the bladder is demolished. This leaves the bladder damaged and atonic, favoring residual collections of urine. It is well known that catheterization of the healthy tonic bladder seldom causes cystitis, but in the atonic distended bladder, catheterization, with the strictest aseptic precautions, is, as a rule, followed by a cystitis.

Given these predisposing factors, which of them can be eliminated or reduced to a minimum? Certainly the trauma to the nerve supply cannot be avoided in an adequate proctectomy. Whether or not the bladder should always be catheterized after a proctectomy is questioned by some surgeons on the ground that the introduction of a catheter certainly means infection, and that if left alone the bladder will spill over and gradually regain its tone. Thus, Davis,<sup>10</sup> and David,<sup>11</sup> of the Presbyterian Clinic in Chicago, avoid catheterization unless the patient shows marked retention, and David<sup>11</sup> does not use spinal anæsthesia because he believes it predisposes to retention. He states that over half of his patients require no catheterization.

On the other hand, there are definite reasons for catheterizing the patients before the beginning of the operation and maintaining an indwelling catheter for four or five days. The catheter outlines the urethra, preventing trauma to the bulbous urethra and facilitating the separation of the rectum from the urinary canal, it prevents distention of the bladder, makes it possible to measure the renal output, which is of great importance in the old and feeble cases, and provides great comfort to the patient. Jones,<sup>12</sup> of Boston, Rankin,<sup>13</sup> of Rochester, and Jones,<sup>14</sup> of Cleveland, employ the indwelling catheter with bladder irrigations. This is done also at the St. Mark's Hospital<sup>7</sup> in London. The infection of the catheter can certainly be reduced by the method proposed by Dukes, which provides for both sterilization of the catheter and bladder irrigation without repeated catheterization. The photograph of the apparatus explains the method now in use at the St. Mark's Hospital in London, as devised by Dukes. This will undoubtedly reduce the incidence of cystitis in the male, and to a lesser degree in the female patients, but there will always be the potential irritation and infection of a foreign body in the urethra, and a cystitis will inevitably occur in many cases.

It cannot be emphasized too strongly that the introduction of the indwelling catheter or of any catheter should be done by an experienced senior member of the interne staff both in the male and female patients. This catheterization of the female cases cannot be entrusted to the rapidly rotating undergraduate nurse. The greatest attention should be paid to the cleansing of the meatus under direct vision.

The second, and in some ways the most serious, complication, especially in the one-stage abdomino-perineal proctectomy, is ileus. I am sure this has not been recognized as often as it should be, for the symptoms are not striking, and the true mechanical ileus is too often thought to be a paralytic ileus. Jones<sup>12</sup> of Boston, considers it the most frequent cause of his post-operative fatalities. It has occurred in eight of our abdomino-perineal cases, and in one of the perineal proctectomies. It is most often caused by the protrusion of a knuckle of small intestine through a break in the repaired pelvic peritoneum, secondly as a protrusion of gut around or to the outer side of the sigmoid colostomy, through the incompletely closed meso-sigmoid, thirdly, as an angulation ileus, due to plastic peritonitis in the repaired pelvis. Failure of the colostomy to function after it is opened, with persistent distention, is evidence of ileus, and unless the distention is promptly relieved by enemas and stupes and pituitin the patient will go down hill rapidly. Operative interference is definitely indicated, and promptly, if conservative measures do not give definite and immediate relief. The patient should be taken to the operating room, and the repaired pelvic floor first examined from below, after removal of the packing, with the patient in the lithotomy position and with good light, to make sure a loop of small intestine is not protruding through the repaired pelvic peritoneum. In one of our recent cases this was done and the loop pushed back and the pelvis repacked. The patient made an uneventful recovery. Jones<sup>12</sup> states in a recent communication that ileostomy relieves a large proportion of the patients with this complication. In another of my own cases, with ileus developing on the fourth day, on finding no loop below I did an entero-enterostomy above, between collapsed and distended loops, and the obstruction was relieved, but after a few days the patient began losing weight and strength and died of inanition twenty-one days later. Autopsy showed the entero-enterostomy between jejunum and low ileum, with the intervening long segment of small gut herniated around the sigmoidostomy through an incompletely closed mesosigmoid.

The best treatment is, of course, preventive, and by careful attention to the smooth repair of the pelvic floor, the closure of the mesosigmoid to the pelvic and lateral pelvic peritoneum, this complication will be reduced. From this standpoint alone, as well as others of which time and the scope of this paper do not permit a detailed discussion, Coffey's<sup>5</sup> two-stage abdomino-perineal operation with the rubber-covered multiple gauze wick drain brought up extra-peritoneally between bladder or uterus and peritoneum favors a more adequate and secure closure of the pelvic peritoneum. This method provides for the closure over a supporting tampon in place during the suturing of the pelvic peritoneum and without the immediate disturbance of the perineal stage of the removal of the rectum and the hurried and more-or-less blind placing of the pelvic pack.

Post-operative hæmorrhage is always a serious complication in patients that have undergone such severe operations. The operation at best results in a considerable loss of blood, demanding a transfusion, as a rule, at the close

of the procedure. Post-operative hæmorrhage occurred in five of the abdomino-perineal operations, in one of the abdomino-perineal with preservation of the sphincter, and in one perineal proctectomy. In our experience secondary bleeding has occurred from the middle hæmorrhoidal branches that had not been ligated, or from the branches of the lateral and middle sacral vessels, as they enter or emerge from the sacral foramina. The latter group of vessels are easily traumatized in the perineal dissection, particularly if the stripping of the contents of the hollow of the sacrum is carried too close to the bone with removal of the pirietal pelvic fascia.<sup>17, 18</sup> We feel that the middle hæmorrhoidal vessels should be ligated during the abdominal stage of the combined operation, and not overlooked in the perineal route.

Sepsis and peritonitis are not the dreaded complications that they used to be, because of the better preparation of patients, the more extensive excisions, with the parts in view, and the wide open drainage. Adequate drainage of the cellular tissues is essential. I know of no more virulent infection than that which takes place in the damaged retroperitoneal pelvic cellular spaces if drainage is not provided. I cannot understand why Lockhart-Mummery<sup>17</sup> in closing the perineal wound without drainage, after inverting the lower end of the sigmoid or pelvic colon, does not have serious infection of the pelvic cellular spaces. For this reason Coffey's use of extensive retroperitoneal gauze wicks coming up between bladder and peritoneum or uterus and peritoneum explains his improved results in the abdomino-perineal operation.

The mortality in such major operations as the abdomino-perineal, when done by several operators on a general surgical service, is uniformly high—well over 30 per cent, judging from figures from several well-known clinics. It has been clearly demonstrated by Miles and Jones that the individual surgeon, doing many of these cases with the advantages of acquired technic and cumulative experience in judging the most favorable operative procedure for the individual patient, can reduce the mortality to below 10 per cent. In any general surgical service this type of surgery should be done by two of the surgeons interested in the subject and each able to do the several operations with the other assisting. Team-work is essential in the pre-operative, operative and post-operative care of these cases. Unless there is team-work, and unless the operations are done by surgeons experienced in this work, the mortality will be prohibitive.

In the Presbyterian Clinic since 1925, as a result of such team-work and of limiting the operations to surgeons with experience in this field, the operative mortality has been reduced from 40 per cent to 17 per cent. We attribute this largely to the improved selection of the operation, the most suitable for the individual patient, and to the type of lesion, to the better pre-operative preparation of the colon, to the better care of the urinary tract, to the better selection of anæsthesia—spinal and gas-oxygen, to the shortening of the operative procedure, as a result of more expert assistance, and finally to a better appreciation of the complications, both in preventing them and in appreciating such conditions as ileus and hæmorrhage in the early stage.



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# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD JANUARY 13, 1932

The President, DR. JOHN R. DOUGLAS, in the Chair

### RECURRENT ADAMANTINOMA OF THE JAW

DR. BRADLEY I. COFFY presented a woman, aged fifty-four, who was admitted to Lincoln Hospital April 14, 1931, complaining of two large tumor masses on the right side of the face (Fig. 1). Thirty-nine years ago the patient first noticed a slowly growing tumor in lower right parotid and submaxillary areas. The mass was never painful. It was always hard and seemed attached to bone. At first it was pea-sized. In 1907 an operation was performed at the Presbyterian Hospital by Dr. Ellsworth Lhot for cyst of the mandible which recurred in a year. He operated again for the same condition in 1910 and a second recurrence followed. Nine years ago she went to the Fourth Surgical Division of Bellevue Hospital for radium-seed implantations by Dr. Harold B. Keves, who asked Doctor Coffy to see her in consultation. Previous to that time she had severe frontal headaches and occasional colds. Growth was very slow at first and the patient was rather unconcerned until one year ago, when her lower right teeth began to ache. Five teeth were extracted by merely pulling them out with the fingers. Following this the mass began to grow rapidly, but it was never painful or red. Nine years ago she noticed a little nodule over her right temporal region. This also was painless and small and did not worry her until two years ago, when growth became exceedingly rapid, but painless.



FIG. 1.—Before operation April 15, 1931

Patient has been in excellent health, has not lost weight recently, nor has her appetite suffered. She had had the usual diseases of childhood. Gave no history of trauma to the jaw or teeth. Examination elicited nothing of interest aside from the local condition. In the right mandibular region there was a large, firm, non-tender, slightly cystic mass, which appeared to arise from the bone. There was a second mass, distinct and separate from the first, located in the temporal region of the same side. There was limitation of jaw movements and especially restriction in degree to which the mouth could be opened. Intra-oral examination showed a bulky tumor occupying the right

alveolar region. It was fungating through mucosa in several places. The neck was the site of two linear scars of the previous operations. There was no adenopathy. Wassermann was negative.

*X-ray findings*—April 14, 1931—Marked swelling of the right lower jaw with large bone defect. Greater part of the horizontal and ascending ramus absent. Bone defect in the right parietal region.

*Operation*—April 16, 1931. Anæsthesia gas, oxygen, and ether. *A*—A curved incision over tumor was carried down to cyst wall. Cyst then exposed down to bony attachments, peripherally. Cyst then exposed and trimmed off, leaving deep bone portion from which pale, yellowish-gray, shiny tumor tissue was removed. Entire cavity was packed with Chlumski during the second stage of the operation.

*B*—Long, curved incision in the hairline, exposing cyst of right temporal region. The greater portion of the cyst wall was excised. The deeper portion, however, together with considerable amount of solid tumor tissue was peeled from the depression in the temporal fossa and removed in one piece. The actual cautery was used to control bleeding. The cavity was packed with gauze soaked in Chlumski during closure of the jaw incision. Both incisions were then closed with black silk and Michel clips. Pipe-cleaner drain was placed in jaw incision and a wick of iodoform packing in temporal incision. The following day the patient was in poor condition and was given a transfusion of 350 cubic centimetres of whole blood by the Lindeman method, using the husband as donor.

In addition, hypodermoclyses of glucose and saline were required to administer sufficient fluids for the first four days. She was discharged with both wounds practically healed on the fifteenth post-operative day.

It was apparent that the tumor which was present in the right mandibular region was not completely removed and the patient was advised to re-enter the hospital for a radical procedure, including resection of the involved area of the mandible. Two months later she re-entered Lincoln Hospital (July 10, 1931) for this purpose. At this time there was no apparent recurrence of the temporal mass, but there was evidence of tumor tissue in the jaw which was apparent upon external and intra-oral examination.

Examination at this time showed a large depression the size of half an orange (small) in the right temporal region which represented the site of excision of the tumor two months previously. The hard, bony mass attached to the lower jaw presented much the same appearance as when she left the hospital. The mucous membrane was ulcerated at two small points, from which rather foul fluid could be gently expressed.

*Second operation*—July 14, 1931. Under oil-ether colonic anæsthesia. Pre-operative diagnosis: solid and cystic adamantinoma of the right side of the mandible. Considerable of the right half of the mandible had been excised at a previous operation done some twenty years ago. There was now a large, solid and cystic recurrence which extended beyond the mid-line as far as the left central incisor tooth. It was closely adherent to the skin in one place and quite adherent to the mucosa throughout most of its extent.

*Procedure*—Incision just to the left of mid-line of chin vertically downward and curving to the right and ending at a point opposite normal angle of jaw. Incision carried down to mandible. Periosteum elevated and jaw divided at this spot with Gigli saw. The right portion, including tumor, was freed from underlying mucosa and, in the main, from overlying skin and the entire tumor removed. Mucosa approximated with silk. Skin flap brought back and sutured with silk. Two rubber drains were used and dead space obliterated with voluminous gauze dressings applied with uniform pressure.

The patient was in mild shock the afternoon of the operation and was transfused with improvement of general condition. Hypodermoclyses of glucose and saline were again used for a period of three days, during which time it was difficult for the patient to take fluids by mouth. She objected to nasal catheter feedings. On the third day the

## RECURRENT ADAMANTINOMA OF THE JAW

drains were shortened and there was marked sero-sanguinous discharge which gradually lessened in amount. One week after the operation it was noted that there was a slight discharge of saliva from the lower angle of the wound, the lip having healed nicely without wound infection. This slight discharge of saliva diminished and the patient was discharged on the eleventh post-operative day with a very minute amount of drainage. This finally ceased and the wound has remained completely healed.

The patient's present condition (Fig. 2) presents a most difficult problem from the standpoint of dental prosthesis. There is very little to work with and it has been a



FIG. 2—After operation. December 21, 1931

difficult task to provide her with a useful denture which, at the same time, improves her appearance. This has been accomplished by her dentist, Dr. Sidney Leistner.

*Pathological report*—April 23, 1931—Slides reveal numerous larger and smaller rounded-cell islands, isolated and confluent, embedded in dense hyalinized fibrous tissue (Fig. 3). The cell groups tend toward alveolar or cystic formation, arranged circularly about a central cavity. A distinct basement membrane is visible surrounding the cell masses, which resemble stratified cuboidal epithelium of three to four layers of thickness. Those nuclei nearest the basement membrane tend toward columnar form, the others are small and rounded, containing much chromatin. Cytoplasmic outlines are obscure. Spines are not visible. The cells resemble the basement cells of the Malpighian layers

of the epidermis. In other areas cell groups are confluent and form solid sheets of cells.  
*Diagnosis*—Adamantinoma of the jaw

Section taken months later resembles previous sections, although there are fewer islands, the cells forming dense and compact masses. Here and there between these massed cells occur peculiar rounded alveoli consisting of columnar cells resting on a basement membrane and surrounding capillaries whose walls are greatly thickened. Between the cell groups the stroma is dense and contains numerous foci of lymphocytes surrounding small capillaries. *Diagnosis*—Adamantinoma of the jaw

This case is of interest particularly because of the unusual duration of the tumor, which all told has been present for almost forty years. Its extremely slow rate of growth and relatively benign nature are apparent from the fact that the first operation for this condition was undertaken twenty-one years ago and that, although the patient states that a recurrence was prompt fol-



FIG 3—Recurrent adamantinoma. Microphoto of tumor. April 16, 1931

lowing this operation and also the one done three years later, she had suffered very little inconvenience during the greater part of this long period.

In this case the tumor was no longer confined solely to the bone and, for this reason, it is extremely difficult to be at all confident that recurrence will not take place from some small soft part area that was unrecognized. Carter\* in a recent issue of the *ANNALS OF SURGERY* reports three cases of adamantinoma of the lower jaw together with radiographs and photographs. His cases were all in women and in all three the tumors apparently began following the extraction of a tooth. Trauma, infection or continued irritation is said to be the stimulus necessary to start the growth of paradental epithelial debris. The slow growth of these tumors is borne out by Carter's cases, in two of which the tumor had been present for twelve years and in the third case for eleven years. Metastasis did not occur in any of his cases. He

\* *ANNALS OF SURGERY*, vol. LCV, p. 1, July, 1931

## DISARTICULATION AT THE HIP-JOINT

refers however to Ewing as having seen metastasis to the cervical glands on two occasions and also to Simmons twelve cases, in two of which there was late metastasis to the cervical glands

All three of Carter's cases developed local recurrence following one or more conservative operations and with each recurrence the tumors re-appeared more promptly and grew more rapidly. Carter favors radical resection of the jaw as the method of choice. All his patients have remained well following this procedure. He mentions the advisability of tracheostomy and the advantage of nasal tube feeding during convalescence

## DISARTICULATION AT THE HIP-JOINT FOR CHONDROMYXOSARCOMA OF THE FEMUR

DR BRADLEY I. COFFY presented a man forty-eight years of age who in August, 1928, began to feel a tingling sensation in the right thigh. This was followed in four



FIG 4—X ray of right thigh (showing tumor)

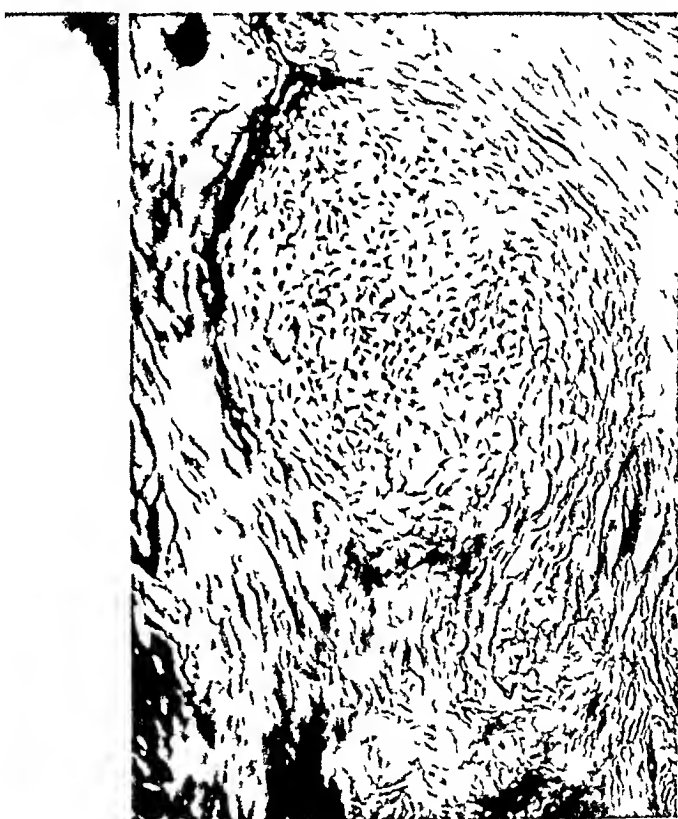


FIG 5—Microphoto of tumor (chondromyxosarcoma)

months by swelling and pain. A diagnosis of osteomyelitis was made at St John's Hospital, Far Rockaway, drainage was instituted in November, 1928, and the operation repeated in June, 1929. A report from the hospital in August, 1929, states that microscopic examination of the tissue removed showed it to be osteochondroma with malignant changes. A second letter stated that the pathological findings were "inflammatory reaction in soft tissues and necrosis of bone." He was referred to the Memorial Hospital in August, 1929.

*Physical examination*—August 21, 1929, showed on the lateral aspect of the right thigh two linear incisions, both healed and presenting a combined length of nine inches. There was no definite palpable tumor beneath these scars. Posterior to the more lateral of the two scars there was a slight sense of deep swelling, ill-defined, and presenting no bone irregularities and no definite line of demarcation. Motions at the hip were not

limited. There was no swelling, redness or other changes in the skin of the soft parts and there was no enlargement of the lymph nodes in the groin.

The urine examination was negative. Blood examination revealed a slight secondary anaemia and relative lymphocytosis with a normal total white blood cells.

X-ray films (Fig 4) were obtained which were reported as showing evidence of a definite and well-developed attempt at repair with callus production along and in the cortex of the outer surface of the upper third of the shaft of the femur. The films lacked the essential features of a neoplastic process.

He was given one exposure of high voltage X-ray and kept under observation and later referred to the Hospital for Ruptured and Crippled as a case of chronic inflammatory disease of the femur. In March, 1930, an exploratory osteotomy was performed because of persistent pain and a histological diagnosis of osteitis fibrosa was made. The wound healed and pain was relieved. A second osteotomy was performed in October, 1930, because of return of pain and, at this time, a large cyst-like cavity filled with soft tumor tissue was exposed and carefully curetted. The pathological report was chondromyxosarcoma.

Amputation was now advised, but declined by the patient until January 30, 1931, when a hip-joint disarticulation, using a tourniquet and Wyeth pins, was performed at Memorial Hospital. He was given a transfusion of 600 cubic centimetres of blood immediately after the operation, which was followed by uneventful recovery and primary wound healing. Coley's toxins were administered during convalescence. He was discharged on the twenty-fourth post-operative day. He is now able to get about on crutches. Although he has been fitted with an artificial limb he has not found it satisfactory.

*Pathological report*—Dr. Fred Stewart Gross—Specimen is that of upper end of the femur. In the region of the greater trochanter there is a marked swelling 5 by 6 by about 2.5 centimetres, cystic in areas, and in others more or less firm and crepitating. On section in the area of the greater trochanter there is replacement by a polycystic tumor mass filled with gelatinous-like material with here and there slight spicules of what appears to be calcifying areas of cartilage. There is thickening of the cortex above the greater trochanter about 3 centimetres in length, but below this there is considerable destruction of the cortex with infiltration of the medullary cavity which extends down to a level 13 centimetres below the greater trochanter. The cortex is eroded along the shaft by this medullary infiltrating tumor mass, and just below it there is marked thickening of the cortex by osteoid bone in an attempt to seal off this tumor invasion. The tumor tissue within the medullary cavity has the appearance and consistence of cartilage in a precalcified state. Just below and opposite the greater trochanter in the inner side of the cortex for a distance of 6 centimetres is a layer of peculiar fibrous and osteoid tissue (Fig 5). This is probably due to the extent



FIG 6—Post operative scan (right side)  
Operation, January 30, 1931

placement by a polycystic tumor mass filled with gelatinous-like material with here and there slight spicules of what appears to be calcifying areas of cartilage. There is thickening of the cortex above the greater trochanter about 3 centimetres in length, but below this there is considerable destruction of the cortex with infiltration of the medullary cavity which extends down to a level 13 centimetres below the greater trochanter. The cortex is eroded along the shaft by this medullary infiltrating tumor mass, and just below it there is marked thickening of the cortex by osteoid bone in an attempt to seal off this tumor invasion. The tumor tissue within the medullary cavity has the appearance and consistence of cartilage in a precalcified state. Just below and opposite the greater trochanter in the inner side of the cortex for a distance of 6 centimetres is a layer of peculiar fibrous and osteoid tissue (Fig 5). This is probably due to the extent

## TRAUMATIC RUPTURE OF SPLEEN

of tumor along the shaft with decalcification leaving in many places only the fibrous framework of the cortex. Below the greater trochanter on the same side the shaft is probably destroyed for a distance of 6 centimetres in a localized area. *Impression*—Chondromyxosarcoma arising on the basis of an enchondroma near the old epiphyseal line of the greater trochanter. Prognosis good.

This case illustrates the difficulties that are occasionally encountered in obtaining a correct diagnosis not only by clinical and roentgenographical examination, but even after repeated biopsies. Yet after four previous surgical interventions there is no evidence of pulmonary metastasis three years after the first exploration and eleven and one-half months after the hip-joint disarticulation. (Fig 6.)

An accurate roentgenographical diagnosis has not been possible in at least 20 per cent of all cases of suspected bone tumor. The dangers of error in diagnosis from biopsy lie in the failure of the surgeon to obtain characteristic tissue. The conflicting histological reports on the material obtained from the earlier biopsies in this case must be explained on this ground. In a slowly growing central sarcoma there is often a peripheral zone which shows reactive bone changes. Unless ample material is obtained an incorrect diagnosis may be made.

### TRAUMATIC RUPTURE OF SPLEEN—SPLENECTOMY AND AUTOTRANSFUSION

DR BRADLEY L. COFFY presented a boy, sixteen years of age, who was admitted to Lincoln Hospital December 3, 1929, with a history of having coasted into a lamppost while on a sled about five hours prior to admission. At the time of the accident he complained of pain in the right shoulder and was treated in the emergency room, where a dislocation was reduced and the patient sent home. At home he began complaining of pain in the upper abdomen, extreme weakness and thirst. The family physician was called in to see the patient and gave him 1/6 gram of morphine and sent him to the hospital.

On admission he was found to be in mild shock, of ashen gray color, cold and clammy. Pupils were in mid-dilatation and reacted to light. Heart rate of 90, sounds of fair quality. Lungs clear. No evidence of fractured ribs. The abdomen was distended. There was a sense of resistance and tenderness in the left upper quadrant. No obliteration of liver dullness. Rectal examination was negative. Blood-pressure 94/48. Temperature 98.6. Hemoglobin 55 per cent (Dare method), red blood cells, 3,400,000, white blood cells, 18,000, polymorphonuclears 84 per cent, lymphocytes 10 per cent, endotheliocytes 6 per cent. Urine clear, specific gravity 1035, acid, sugar, 0, acetone, 0, albumin, 0, microscopic negative.

A hypodermoclysis of 1,000 cubic centimetres of 5 per cent glucose was given and the patient was taken to the operating room, with a diagnosis of traumatic rupture of spleen. Splenectomy and autotransfusion under ether anesthesia.

The abdomen was distended with blood estimated at about 1 litre. The intestines were collapsed. The spleen presented a large tear on the convex surface opposite the hilum. Blood was bailed out and preserved for autotransfusion. Spleen was then delivered, the pedicle clamped, spleen removed and the pedicle ligated with No. 1 chromic catgut. The abdominal wall was then closed in layers without drainage.

Autotransfusion was commenced at the time the pedicle of the spleen was being ligated and continued during the closure of the abdominal wall. This was rendered



necessary by the extremely critical condition of the patient whose pulse became imperceptible. In the opinion of the anæsthetist, he was about to collapse. Fifteen hundred cubic centimetres of a mixture of the patient's blood and saline (1:2) were given, so that he received 500 cubic centimetres of blood and 1000 cubic centimetres of saline. Meanwhile a donor was obtained so that shortly after the operation he received a transfusion of 350 cubic centimetres of whole blood. The following day another transfusion was given, using 350 cubic centimetres of blood.

The patient made an uneventful recovery except for an acute follicular tonsillitis. He was discharged with wound healed December 24, 1929.

The patient was re-admitted May 14, 1931, with a mild influenzal infection from which he made an uneventful recovery. His abdominal wound was firmly healed. At this time the following laboratory data were obtained: Blood sugar, 0.87; Blood urea nitrogen, 18.0; Wassermann, negative; White blood cells 26,500, polymorphonuclears 70 per cent, lymphocytes 30 per cent. *Platelet count* 184,000.

On December 7, 1931, an examination of the blood showed: Red blood cells 4,200,000, white blood cells 7,900, hæmoglobin 86 per cent, polymorphonuclears 46 per cent, lymphocytes 54 per cent. *Platelet count* 310,000.

This case was shown to illustrate the value of autotransfusion in cases of massive hæmorrhage into the abdominal cavity. A similar case was presented by Doctor Coley before the Surgical Section of the Academy of Medicine November 24, 1927.

The earlier case was a male of thirty-six who was admitted to the Second Surgical Division of Bellevue Hospital with a history of having fallen a distance of six feet, striking his left side across a wooden brace. Although a diagnosis of ruptured spleen was made on admission, the patient would not consent to immediate operation and it was five hours from the time of injury before operation was finally performed. His blood-pressure fell the first two hours after admission to 65/47. At operation a ruptured spleen was removed and 750 cubic centimetres of blood, which was strained through gauze, was obtained from the unclotted blood in the peritoneal cavity and transfused directly into the right cubital vein by an assistant. The transfusion progressed simultaneously with the closure of the abdomen and was followed by the administration of an additional 300 cubic centimetres of normal saline solution.

This patient made an uneventful recovery, leaving the hospital on the fifteenth post-operative day with the wound healed by primary union, and was presented some fifteen months after the accident without symptoms and engaged in his former occupation of ironworker.

Hamilton Bailey has classified cases of ruptured spleen in four groups: (1)—The patient rapidly succumbs, never rallying from the initial shock. (2)—Initial shock—recovery from shock. Signs of ruptured spleen. (3)—The signs of an intra-abdominal catastrophe are delayed. (4)—Spontaneous recovery. The case now presented apparently belongs in Group 3 of Bailey's classification.

DR. WILLY MEYER said that several years ago, in summer, during a severe heat wave, he was called to see a boy who had been injured in the street by an automobile. The boy had been struck in the side and the diag-

## ACTINOMYCOSIS OF KNEE

nosis of rupture of the spleen was made. After operation everything went well but he developed, at the same time with two other operative cases, an elevation of temperature to between  $106^{\circ}$  and  $107^{\circ}$ . This was found not to be a reaction from the wound but due to the tremendous heat prevailing at that time. The cases all recovered.

DR RUSSEL H. PATTERSON said that he had done two autotransfusions. One patient had a hemothorax following fractured ribs. There was so much respiratory and cardiac embarrassment that aspiration of the blood was necessary. The patient was very anemic. The blood was filtered through gauze into a basin and with a needle in the vein syringes full of the blood were given to the patient until he had received about 700 cubic centimetres of his own blood. The second patient was a case of ectopic pregnancy. The woman had lost a lot of blood and was marble white. The donor did not arrive quickly enough so 800 cubic centimetres of blood was removed from the pelvis during the laparotomy. The blood was removed with a cup and strained through gauze into a basin and was then given back to the patient in one of the veins of the arm by means of a syringe and cannula. Both these cases recovered without any harm and apparently with much benefit from the autotransfusions.

DOCTOR COLLY, in closing the discussion, said that the beneficial effects in the previous case of ruptured spleen in which he had done autotransfusion had caused him to prepare for this procedure before operation was done. All the blood was strained through gauze and to it was added warm, normal saline solution, care being taken not to have it above blood heat. Two men were working simultaneously and it took less than ten minutes to get in the 1,500 cubic centimetres of blood and saline solution.

## ACTINOMYCOSIS OF KNEE

DR CHARLES E. FARR presented a boy, four years old, who entered St. Mary's Hospital for Children May 8, 1931, on account of a swollen right knee with many discharging sinuses.

Six months before admission the boy, while playing in the house, fell, striking his right knee. The following day the knee was swollen. The child was taken to various clinics, X-rays were taken which were pronounced negative and finally the joint was aspirated four times on different occasions. As this was unsuccessful, no fluid being obtained, further X-rays were taken and again pronounced negative. As a last step the knee was incised on three different visits and finally pus was obtained. An X-ray taken two months ago was again negative. The knee continued to discharge profusely. The family physician noted in the discharge a number of yellow granules.

The right knee was greatly swollen, red and moderately tender. There were a number of discharging sinuses and a profuse growth of exuberant unhealthy granulations. Yellow amorphous material appeared in one sinus and was sent to the laboratory for search as to sulphur bodies. There was marked spasm of the knee. The femoral nodes were greatly enlarged but not tender. (Fig 7)

The boy ran a septic temperature, as high as  $104^{\circ}$  F. This was partly relieved by an operation for drainage May 12. The knee-joint was found wide open and full of pus and debris but without involvement of bone or cartilage. Many large tumor-like masses

were found about the joint and in the various sinuses. A handful were removed for study. The clinical findings were of no great aid. There was a moderate secondary anæmia, 3,520,000 red blood cells, and 70 per cent hæmoglobin. The leucocyte count ranged from 12,000 to 20,000, the polymorphonuclears from 75 per cent to 79 per cent. All other blood findings were normal. This included Wassermann blood tests on the child and the entire family. The urinalysis was normal. The blood culture was sterile. Nose and throat findings were normal. The intradermal tuberculin test was strongly positive on several occasions. Smears from the wounds showed many organisms, staphylococci, streptococci, a very few acid-fast organisms resembling tubercle bacilli and many actinomyces. Cultures showed streptococcus hæmolyticus and actinomyces. These smears and cultures were repeated at the New York Hospital laboratories and the findings were identical. A number of X-rays of the knee and of the chest were reported



FIG 7—Limb amputated on account of actinomycosis of knee



FIG 8—Face of section of the amputated portion seen in Fig 7

negative except for soft-part swelling and finally slight erosion of the lower epiphysis of the femur.

The treatment consisted of large doses of potassium iodide, cod-liver oil, ultra-violet rays, and finally X-ray. Whole blood transfusions were given May 12 and June 15. There was no improvement and the general condition of the boy became steadily worse. Locally there was an increase in the size of the knee, of the spasm and of the discharge. The femoral nodes were now very greatly enlarged, forming a mass 4 by 5 centimetres and 3 centimetres deep.

Microscopic examination of the tissues removed from the knee on May 12 revealed the following. Two roughly spherical masses each approximately 2 centimetres in all diameters. There is an apparent point of attachment on each but the rest of the surface is fairly smooth and covered by a thin, reddish membrane. On section the tissue is found to be spongy, chiefly reddish in color, but there are some whitish areas found. Microscopic sections were stained by the ordinary methods, also Mallory's for connective

tissue Van Gieson phosphotungstic acid Gram, cosin methylene blue and tubercle bacilli stain. The bulk of the specimen is composed of interlacing strands of connective tissue. These are more closely packed than is usually found in a granulomatous process. The strands are separated from one another by rather implectic spindle-shaped cells. Mitoses are found in small numbers. A few tubercle-like bodies are found in this but no tubercle bacilli have been found in these or elsewhere. There are a few small processes on the edge of the specimens where the tissue is rather necrotic. In one of these there are a few filaments which might well represent mycelium of a fungous form. These are stained with Gram but they are not recognized in the carbol fuchsin stained specimens. Streptococci and other bacteria are recognized. Without bacteriological study the pathologist was inclined to place the tissue in the general group of fibrosarcomas where it may well belong, but in view of the cultural studies and the findings noted above the case seems to represent the reaction of tissue to a fungus infection (Olcott).

On May 27 at the New York Hospital a guinea-pig No. 0304 was injected with 0.7 cubic centimetre suspension from the node in the knee. On June 24 0.3 cubic centimetre old tuberculum was injected. Aired died July 17 (fifty-one days after inoculation). Autopsy shows many very fine hemorrhagic points in liver. Spleen moderately enlarged and nodular with many grayish nodules.

Microscopic section shows cellular proliferation in the liver, and in the spleen rarely typical tubercles with endothelial cell proliferation and very few giant cells. This would pass for tuberculosis were it not for the isolation of actinomycosis in the bacteriological laboratory. This makes it probable that the guinea-pig condition is also actinomycosis and that the lesions are similar.

Because of the evident failure of treatment a pudendum amputation was performed June 16, 1931 and a packet of nodes removed from Scarpin's triangle. This was considered only a palliative measure as the process certainly extended well above the line of amputation.

Recovery was rapid and healing progressed slowly but surely. The boy was discharged September 1, 1931 nearly healed and in excellent condition. He was re-admitted to the Medical Service in November suffering with a lobar pneumonia and again made a rapid recovery. X-rays of the chest at this time were quite suggestive of pulmonary tuberculosis. On January 11, 1932, a further X-ray study suggests but does not affirm hilar tuberculosis.

The final pathological reports are as follows:

June 16, 1931—Femoral lymph node. Ovoid mass 3.3 by 2.3 by 2 centimetres. Capsule smooth intact semi-opaque and moderately injected. The tissue is firm but elastic. On section the capsule is about 1 millimetre in thickness. Under this is a row of small, irregularly spherical, brown masses, each about 3 millimetres in diameter. The central tissue is a lighter red with whitish strands running through it and converging at a point where the surface is somewhat indented and the brown masses are absent. Frozen section shows a few lymphocytes at the periphery. The bulk of the specimen consists of a structure which might be considered a fibroma if the history were not known. The paraffin sections with differential stain show smooth muscle in the lymph node. No tubercle bacilli or other organisms have been found.

June 19, 1931, paraffin sections show the same fibroma-like morphology with, in addition, some small areas which resemble the usual picture of tubercles. The cells rather less anaplastic than in the frozen section. Taken alone the picture would be considered a fibroma or fibrosarcoma. The difficulty is in establishing whether or not the fungus present in the preceding specimen might be considered as a secondary invader.

*Supplementary report, August 6, 1931*—Tuberculous granuloma—lymph node and leg—atypical—pseudo-sarcomatous reaction (Fig. 8). Microscopically, there is a definite mass of tissue which resembles the tumor-like area—in a vessel. In another section there are quite definite tubercles. In some cases these are little more than single

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On May 27 at the New York Hospital a guinea-pig, No 6464, was injected with 0.7 cubic centimetre suspension from the node near the knee. On June 24 0.3 cubic centimetre old tuberculin was injected. Animal killed July 17 (fifty-one days after inoculation). Autopsy shows many very fine hemorrhagic points in liver. Spleen moderately enlarged and nodular with many grayish nodules.

Microscopic section shows endothelial proliferation in the liver, and in the spleen fairly typical tubercles with endothelioid cell proliferation and very few giant cells. This would pass for tuberculosis were it not for the isolation of actinomycosis in the bacteriological laboratory. This makes it probable that the guinea-pig condition is also actinomycosis and that the lesions are similar.

Because of the evident failure of treatment a mid-thigh amputation was performed June 16, 1931, and a packet of nodes removed from Scarpa's triangle. This was considered only a palliative measure as the process certainly extended well above the line of amputation.

Recovery was rapid and healing progressed slowly but surely. The boy was discharged September 1, 1931, nearly healed and in excellent condition. He was re-admitted to the Medical Service in November suffering with a lobar pneumonia and again made a rapid recovery. X-rays of the chest at this time were quite suggestive of pulmonary tuberculosis. On January 11, 1932, a further X-ray study suggests but does not affirm hilar tuberculosis.

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Langhans' giant cells, in others there are small masses of cells. In view of the guinea-pig finding (No 6464) with its typical hyperplastic tubercles, there seems little doubt that the process represents tuberculosis. However, the pseudo-sarcomatous picture is extremely remarkable. It is possible that the absence of characteristic Van Gieson staining reaction is associated with an endothelial process rather than a myomatous. The fungus must be considered as a possible secondary invader. (Olcott)

This case is reported because of the extreme difficulty in establishing a final diagnosis. It seems quite certain that the boy had actinomycosis. The possibility of tuberculosis is present, supported by the positive tuberculin test, the finding of rather doubtful acid-fast organisms in the wound secretion, of fairly typical tubercles in the original specimen in the femoral nodes, and of more doubtful ones in the inoculated guinea-pig.

Against tuberculosis are the facts that the acid-fast organisms were very few and atypical in appearance and staining, the inoculated guinea-pig did not die after being injected with tuberculin, and the child recovered after a manifestly inadequate operation, and later from an attack of pneumonia.

For sarcoma we have fairly typical gross and microscopic findings in the original growth and in the metastatic nodes.

The fact that the child is alive and well eight months after a very incomplete operation is strongly against the diagnosis of sarcoma.

Clinically the diagnosis remains actinomycosis of knee.

#### CARCINOMA OF SIGMOID-COLON INTUSSUSCEPTION

DR CHARLES E FARR presented a man, sixty years of age, seen in consultation on January 26, 1930, with a history of intestinal obstipation and bleeding, intermittent, of about two years' duration. For two days there had been obstipation and bleeding from rectum. *Examination* showed a bleeding mass in rectum, distention of abdomen.

January 28, 1930—When he was admitted in the hospital, all signs and symptoms had disappeared, but a barium enema showed about the middle of the sigmoid or just above the rectosigmoid junction a large, jagged, filling defect, either carcinoma or abscess. Proctoscopic and sigmoidoscopic examinations were made. A small pedunculated growth was seen at the rectosigmoid juncture. It was removed by electric snare February 4, 1930. The growth was 10 centimetres from the anus. *Microscopical examination*—Adenomatous polyp.

August 10, 1930—Well until now. Return of bleeding and obstipation. *Physical examination*—Negative. Exploratory laparotomy was done under spinal anaesthesia. Tumor found in upper sigmoid, 4 centimetres in diameter and *invaginated* (Fig 9). A Mikulicz operation was performed without difficulty. Recovery was uneventful although the final closure of the faecal fistula was somewhat difficult. The man now appears in vigorous health and has no symptoms.

The case was presented because of the intussusception. This must have occurred intermittently for over two years. The tumor was easily felt during the attacks but disappeared in the intervals. Much valuable time was lost because of the failure to follow up the X-ray findings. The tumor was beyond the reach of the sigmoidoscope. The removal of a benign adenoma simply confused the picture further.

*Pathological report*—The specimen consists of about 16 centimetres of large intestine, curved on itself as if it had been removed from the abdomen in a previous stage of the operation. The intestine is about 5 centimetres in diameter and the whole mass 12 by 10 by 10 centimetres in size. The serosa is cloudy. The lumen has been opened up. A papillary projection about 2.5 centimetres in both diameters and 0.6 centimetres

## CARCINOMA OF SIGMOID-COLON INTUSSUSCEPTION

in height was found on the mucosa of the outer border of the arch. Most of the surface of this was ulcerated. The process does not seem to extend far into the intestinal wall and there is little or no obstruction of the lumen of the intestine. Several paraffin sections made. One of these shows a characteristic area of gelatinous adeno-carcinoma. It seems to be small and to have invaded the tissues only just below the surface.



FIG. 9.—Carcinoma of sigmoid colon intussusception

Doctor Farr stated that this was the second intussusception of a carcinoma of the sigmoid he had treated. The other was promptly recognized and properly treated.

DR ALLEN O WHIPPLE said that a year ago he had the experience of operating on a case diagnosed as carcinoma of the rectum, having seen the growth 8 to 10 centimetres above the anal margin by proctoscope. After



opening through a mid-line incision no carcinoma of the rectum could be found. But on examining the sigmoid, in the upper third was a well-defined annular growth which was excised with an end-to-end anastomosis. There have been several examples where the growth telescoped down into the rectum and this possibility should be emphasized because there is no mention of it in the literature on carcinoma of the rectum.

DR. WILLY MEYER emphasized the necessity of recognizing the possibility of intussusception in the presence of malignancy of growths in the rectum. The speaker had seen it in a growth of the cæcum which was carried into the transverse colon. In another case, a young girl complained of pain in the region of the transverse colon and there were signs of sudden, acute obstruction requiring exploration. The tumor was a lipoma of the large intestine.

DR. JOHN DOUGLAS referred to a case on which he operated several years ago. The operation was started with the posterior approach, the growth slipped away and he stopped operating from below and did a Mikulicz type of operation. In a second case, on examination a carcinoma was felt within 3 inches of the anal margin but on subsequent examination it went up to 14 inches from the anal margin and could not be felt per rectum. In that case it was easy to do a Mikulicz operation. If one feels a tumor and cannot determine on which side of the rectal wall the tumor appears to take its origin, it is possibly one of those cases which prolapse. This possibility must be kept in mind.

#### SARCOMA OF CERVICAL VERTEBRA

DR. CHARLES E. FARR presented a girl, sixteen years of age, who was referred to him three years ago because of severe intermittent pain in the left side of the neck. She entered the New York Hospital January 10, 1929.

This cervical pain was of eight months' duration. There was a marked feeling of stiffness and sharp pain on any abrupt movement. This was temporarily relieved by baking and massage. After a month's respite from treatment the pain became more severe and lasted longer, two or three hours instead of a few minutes. An added symptom was a dull ache on the outer aspect of each arm and forearm, also intermittent. Many treatments were tried by several physicians, without benefit.

The past history was negative except for chicken pox (nine years ago), measles (two years ago), mumps (six years ago), scarlet fever (four years ago), and swollen glands in the neck (seven years ago). The tonsils had been removed five years ago.

Examination revealed nothing except slight limitation of extension of the neck, and marked tenderness throughout the posterior triangle of the left side of the neck. Consultations with two neurologists and a physician resulted in a unanimous verdict that the trouble lay in the fourth or fifth cervical vertebra, and was probably not tuberculous.

Repeated X-rays showed no definite changes in the bones. Urinalysis was negative, blood counts were normal, intradermal tuberculin tests were negative, and four Wassermann tests, including one provocative, were normal. The temperature was sub-febrile, 98° to 100° F.

An exploratory operation was done January 23, 1929. Through a transverse incision behind the left sternocleidomastoid muscle, the transverse processes of the fourth, fifth and sixth cervical vertebrae were exposed. They seemed slightly rough but no definite infectious lesion could be found. All soft tissues, especially the muscles, seemed contracted, even partially cicatrized.

## SARCOMA OF CERVICAL VERTEBRA

The child made an excellent recovery and was allowed home on the ninth day. She continued to improve for about a year but was never quite free from symptoms. She was seen by an orthopedic physician, Doctor Boonstein, who had another X-ray taken and referred her back to Doctor Farr with the proper diagnosis of new growth of the spinous process of the sixth cervical vertebra. A review of the original films immediately disclosed a tiny lesion about 3 millimetres in diameter in the spinous process of the sixth cervical which had been completely overlooked.

By now the growth had involved the fifth spinous process (Fig. 10) and was causing distinct cord symptoms in the arms. She was again operated upon in the New York



FIG. 10.—Giant cell sarcoma of cervical spine.

Hospital December 17, 1930. Through a vertical incision the spinous processes of the fifth and sixth vertebrae were exposed and removed. They were nearly completely destroyed by the growth which also impinged on the lamina. The posterior fascia of the canal was exposed but it was not involved. No spinal fluid escaped—no spinal nerves were seen although the cord was clearly visualized. The entire wound was vigorously curetted.

Again recovery was uneventful. The child wore a leather collar for several months and has received fairly intensive X-ray treatment. She now is perfectly well, has no symptoms, has nearly perfect function of the neck, and the X-ray shows an excellent fusion of the fifth and sixth cervical vertebrae.

The great interest of this case lies in the fact that with the most intensive study in two large clinics and by many private physicians the diagnosis was not made for two and one half years, although it really appeared in the early X-ray plates

The laboratory reports are appended They explain the extreme rarity of the condition and perhaps offer a slight excuse for the delay in diagnosis

Laboratory No 42,872 and No 42,863—Specimens received the morning of operation and later that day are essentially similar They come from the tissue of cervical vertebræ In both together there are about twenty pieces of pinkish tissue, some partly bony The largest ones are a centimetre or so in length

Microscopically, they are made up of tissue which is in part quite dense, in others less so Two types of cells predominate, one appearing to represent osteoblasts which

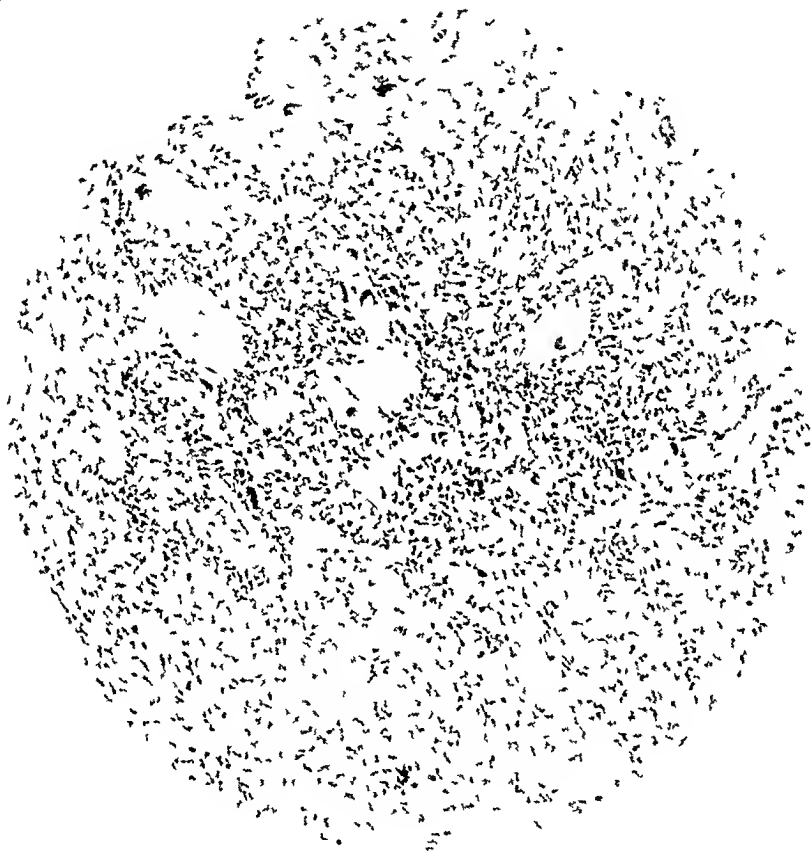


FIG 11—Giant cell sarcoma of cervical spine

are laying down osteoid and also relatively regular bony trabeculae, while in other areas "epulis"-like giant cells predominate Here the process is essentially bone-destroying The picture (Fig 11) seems to fit in with that of a low-grade, bone-producing sarcoma, rather more definitely than with that of a strictly benign giant-cell tumor The rather slow growth of the process, clinically, fits in with the pathological picture

Doctor Ewing has seen the slides and above is in part based on his study He does not recall having seen either benign or malignant bony tumor in the cervical vertebræ  
*Diagnosis*—Giant-cell tumor or osteogenic sarcoma

This case has been registered in the "Registry of Bone Sarcoma" as No 1186 We are informed that in the registry there are twenty-seven tumors of the vertebrae Of these, only three were located in the cervical region, namely No 44, a benign giant-cell tumor of the third, fourth and fifth cervical regions, No 1018, a giant-cell tumor, malignant, of the fourth, fifth, sixth and seventh cervical vertebræ, and No 1032, osteogenic sarcoma of the sixth (right) cervical vertebra

## INOPERABLE CANCER OF STOMACH

### INOPERABLE CANCER OF STOMACH RESULT OF ACIDOSIS TREATMENT FOLLOW-UP THREE YEARS

Dr. WILLY MIXER presented a woman the history of whose case was published in detail in the last issue of the American Journal of Surgery, January, 1932

*Recapitulating*—Gastric trouble in the spring of 1928. At Battle Creek Sanitarium cancer of the wall of the stomach was diagnosed and pronounced inoperable. Desiring operation, the patient went to Rochester, Minnesota, where Dr. Charles H. Mayo did an exploratory laparotomy October 31, 1928. There were many adhesions in the upper right abdomen, secondary to an appendectomy and cholecystostomy done elsewhere in 1916. The upper three-fourths of the stomach including all the posterior wall and part of the anterior wall was involved with carcinoma, there was also involvement of the lymph nodes about the cardia just beneath the diaphragm and along the spine. A gland removed from the gastrosplenic omentum for biopsy showed carcinoma. As there was no obstruction a gastroenterostomy was not done and the abdomen was closed as an exploration. Eleven days later the patient left the hospital and soon returned to New York with a fatal prognosis.

Her husband, having read in the newspapers about Professor Fischer-Wasels and Holfelder's cooperative work at Frankfurt University, Germany, arranged for the transfer of the patient to that city. On December 9, 1928, the acidotic treatment as used there for some time in inoperable cases of carcinoma was started. This consisted of increasing doses of hydrochloric acid internally, inhalation of a mixture of oxygen and carbon dioxide, 95.5 to 4.5 per cent, two hours daily and deep X-ray irradiation for fifteen minutes once a week.

After four months the tumor had disappeared, as proved by the X-ray film. The patient returned to New York in May, 1929, continuing here the acid treatment internally to date, and the gas breathing until September, 1929.

Today, somewhat longer than three years after the beginning of the acidotic treatment, she is still in perfect health. Clinical examination for recurrence and metastases is negative. To all appearances the patient has to be considered cured. The pH of the blood is carefully watched here. Should it rise to and above 7.40 gas inhalation will have to be resumed.

Of course, one swallow does not make a summer. A series of similar observations is required before one can venture to draw conclusions. Yet, the experience had with this treatment demands continuation of the work.

The speaker had advised the acidotic treatment in his recent book on "Cancer" on the basis of a careful study of the so-called miraculous cures of inoperable cancer cases, as reported in the literature. In every instance the effect of what had been used or what had occurred incidentally pointed to acidosis.

It seems that those who practice acidotic treatment in inoperable cancer are on the right track in their endeavor to improve the condition of these usually hopeless cases, perhaps even to helping them definitely and permanently. That means, of course, those who believe in the possibilities of acidotic therapy in these cases. But this is not a one man's nor a one hospital's job. The surgeons of the whole country, nay, of the whole world should step in and assist in solving the many problems constantly arising.

The clinical work should be done in closest cooperation with the members of other branches of medicine, the pathologists and the cancer research

workers as well as with the representatives of affiliated branches of science, as biological physicists, biological chemists and experts in the electrical field

There is unquestionably, we believe, something promising in the acidotic treatment of inoperable malignant tumors, combined with deep X-ray irradiation or radium-ray application

The case presented shows the truth of the statement made that "inoperability does not necessarily mean incurability"

DR EDWIN BEER said that he had seen a number of cases which had received the acidotic treatment and in none had there been any cures. The more one thinks one knows of malignancy, the less one finds one knows, which is well illustrated by the following unusual case that had no kind of post-operative treatment, whether acidotic or rontgen, and who carried quiescent metastases from a malignant uterine growth for eleven years.

Within the last six months, the speaker saw a woman on whom a total hysterectomy for adeno-carcinoma of the uterus had been performed eleven years ago. The patient came to him for hæmaturia. She had a post-operative ventral hernia and a nodule was present, supposed to be omental, but proved to be adeno-carcinoma. Moreover, half the bladder was taken out for an infiltrating tumor. At the time of the operation for the hernia and bladder neoplasms, Doctor Beer did not know of the pathology found at the previous operation, but he got in touch with the laboratory of the Roosevelt Hospital, and found that the microscopic diagnosis on the uterine growth was adeno-carcinoma, identical with the microscopic picture of the hernial and bladder neoplasms. All slides were compared. While the patient was convalescing from the bladder operation, another adeno-carcinoma was detected on the labium minus, and removed. In this case, there were at least three malignant metastases some eleven years after the hysterectomy. Five months have elapsed since Doctor Beer's operations, and the patient seems in perfect health.

DOCTOR MEYER, in closing the discussion, reiterated his belief in the value of the acidosis treatment, demonstrated by the presented case. There was abroad one other case he remembered in particular, a case of recurrent cancer of the breast. The woman had a metastasis in the brain, diagnosed by the Professor of Neurology and Ophthalmology of the University of Frankfurt. Under acidosis treatment both the tumor and the metastasis disappeared. Neither X-ray nor radium therapy alone could have accomplished this. Basing his opinion upon such cases Doctor Meyer ventured to state that there seems to be value in the method of this treatment used abroad in combination with or without X-ray or radium treatment. Deep X-ray treatment also produces acidosis. Other methods are being worked out at the Lenox Hill Hospital.

His object in presenting this case, Doctor Meyer said, was to try to interest his colleagues in giving the acidosis treatment a test in cases of inoperable cancer. It is true, nobody wants to place them in the surgical wards, but one or two beds could be set aside for them, for it is only gradually and by cooperation of many clinicians that the real value of the acidosis therapy can be determined.

## THROMBOSIS OF SPLINIC AND PORTAL VEINS

### THROMBOSIS OF SPLINIC AND PORTAL VEINS WITH RECANALIZATION SPIENECTOMY FOR GIANT SPLEEN

DR EDWIN BEER presented a boy, fourteen years of age, admitted to Bellevue Hospital Fourth Division October 18, 1928, with the following history. Family history negative, one brother, three sisters in good health, father and mother living and well. No history of tuberculosis or malignancy in the family.

In 1925 the boy had been in New York Hospital for seven weeks and was discharged with diagnosis of intestinal tuberculosis, arrived at through barium series, which showed filling defect of the caecum. X-ray of the chest showed signs of tuberculosis of the hilus. Patient had had no operations, as a child had had diphtheria.

The chief complaint on admission to Bellevue was vomiting of a large quantity of blood which came on suddenly unprovoked while at school. He also had pain and cramps in the abdomen and nose bleeds. The patient was pale and anemic. Examination showed palpable spleen in the upper left quadrant, some tenderness in the epigastrium. Clinical impression was typhoid fever or tubercular ulcerations with hemorrhage. Further study of the patient led to an exclusion of both these diagnoses and it was suspected he might have a bleeding gastric lesion. He vomited repeatedly and passed tarry stools on numerous occasions. Vomited blood was bright red.

His condition became worse, so that he had to be transfused during the months of October and November five times. Throughout this period he ran a moderate temperature and at times was almost stuporous. Blood count showed 1,000,000 red blood cells, 18 per cent hemoglobin, 13,000 white blood cells with 91 per cent polymorphonuclears. Platelet count was normal. While under observation no purpuric spots developed, and there was no evidence of any disturbance in clotting time nor bleeding time.

Suddenly an ascitic accumulation developed with distention rather extreme, of the whole abdomen. By the first week of November the spleen which had been just palpable became much more distinctly palpable, also enlarged and firm. Wassermann reaction on repeated tests was negative.

He was seen repeatedly by the various members of the staff, and one of them suggested tardy hereditary specific splenomegalia with hepar lobatum associated with thrombosis of portal vein which would account for the very rapid development of ascites. As the ascitic fluid slowly but definitely disappeared the mass in the left side of the abdomen which was thought to be spleen, seemed to become more evident.

In view of the previous diagnosis made at the New York Hospital, some of the clinicians were inclined to think that in addition to the spleen, the whole descending colon was involved in a hypertrophic tuberculosis. According to the medical history, there were two masses, one under the costal margin the other just below it, latter mass extending into the left iliac fossa, corresponding to the course of the descending colon.

In December before Christmas, the boy was allowed to leave the hospital for the holidays, having improved, no more bleeding, ascitic fluid had disappeared, but there was still this large mass in the left side of the abdomen.

January 9, 1929, the boy was seen by Doctor Beer for the first time. A diagnosis of splenomegaly was made, with acute thrombosis of the splenic vein, previous thrombosis of the portal vein with recanalization. With this diagnosis, operation was recommended, and January 14, an enormous spleen was removed through a subcostal incision parallel to the costal arch. The spleen was surrounded by adhesions and innumerable varicose veins, which entered the splenic hilus. There was no ascites, liver was smooth and not enlarged. The most interesting thing, outside of the size of the splenic mass, was the innumerable large veins, which had apparently substituted for the obliterated splenic vein. Over sixty separate vessels and groups of vessels had to be ligated before the spleen could be delivered. These veins also ran from the splenic flexure of the colon into the lower pole of the spleen. The pancreas was easily separated from the hilus.

Patient was transfused after operation, and except for a collapse of the left lower lobe, made an uneventful recovery

The specimen weighed 895 grams, was  $14\frac{1}{2}$  inches long, and  $5\frac{3}{4}$  inches at its greatest width, firm in consistency, smooth surface with round borders Hilus surface presented numerous ligations longitudinally arranged and extending from tip to tip The markings were obliterated Histological changes suggested chronic syphilitic splenitis

The patient was reexamined the other day, three years approximately since the splenectomy, and found to be actively engaged as a fireman on a boat, and apparently in perfect health The subcostal incision is perfectly healed, without any weakness, and his abdominal examination is negative Blood examination shows normal conditions with Howell-Jolly bodies in the red blood cells (Rosenthal)

DR DEWITT STETTEN said that in 1922 he had the opportunity of operating on a case similar to Doctor Beer's, but with, unfortunately, not the same successful outcome The patient, a male, twenty-one years old, was referred to him from the medical service of the Lenox Hill Hospital with a history of sharp sticking pain in the left side of the abdomen and lumbar region with vomiting The patient had been ill for two weeks prior to his admission to the hospital Upon admission he had a moderate splenomegaly, which rapidly increased to unusual proportions while under observation during a period of two weeks The patient at first was in very good condition The temperature was relatively low,  $100^{\circ}$ , but it gradually rose to  $103-104^{\circ}$  just prior to the operative interference when the patient's condition became critical His pulse was rapid and thready and he was in a state of delirium There was also a rather marked leucocytosis The pre-operative diagnosis of acute splenomegaly due probably to abscess of the spleen or possibly to a rapidly growing primary neoplasm such as lymphosarcoma was made At operation Doctor Stetten found an enormous purplish and dark-gray mottled spleen showing areas of infarction with necrosis and hæmorrhage, and an extensive thrombosis of the splenic vein, but no discoverable portal vein thrombosis as apparently existed in Doctor Beer's case No evidence of typhoid fever or other possible causative factor was found at operation The patient succumbed and, as no post-mortem examination was made, the etiology of the condition was never definitely explained The speaker believes, however, that the case was a primary splenic vein thrombosis and feels that, had the diagnosis been made a little earlier or at least the operative indication decided upon sooner before the patient's condition became so alarming, he might have been saved As to the incision for splenectomy Doctor Stetten said he also favored the oblique incision parallel to the costal arch, but that he preferred to make it a little nearer to the arch than the one used by Doctor Beer in his case One should be guided by the size of the splenomegaly as regards the proximity to the costal arch—the larger the spleen, the further away should the incision be from the arch Doctor Stetten has never experienced any difficulty in doing the splenectomy through this incision, nor has he ever seen any subsequent weakness of the scar

## TWO-STAGE ABDOMINOPERINEAL OPERATION OF RECTUM

DR EDWARD J DONOVAN said that he had used the same incision as that used by Doctor Beer at least fifteen times, and, so far has not had a ventral hernia develop. This incision gives an excellent exposure of the spleen, and although one cuts across at least four intercostal nerves, the incision will remain secure if closed carefully in layers.

## TWO-STAGE ABDOMINOPERINEAL OPERATION FOR CANCER OF THE RECTUM BY THE LAHEY TECHNIC

DR. HERBERT WHIT MIXER presented a man, sixty years of age, who in June, 1931, was admitted to the Surgical Service of Dr. Carl Eggers at the Lenox Hill Hospital with the complaint of pain in the lower abdomen and rectal bleeding. From the history, physical examination, X-ray, clinical, laboratory tests and biopsy a diagnosis of adenocarcinoma of the rectosigmoid was made.

This surgical problem immediately brought up the problem which method of approach afforded the best solution for the total removal of the lesion. It was decided to do a combined abdominoperineal operation in two stages with the formation of an end colostomy.

Appended is a chart of the different methods of two-stage operations together with the principles of the operations, their advantages and disadvantages.

By examination of the chart it is seen that the most ideal procedure is the one-stage operation with formation of a colostomy and removal of the lower segment in lesions situated at the junction of the sigmoid and upper rectum. The formation of a sacral colostomy is more disagreeable for the patient and more difficult to care for. In lesions situated at the upper rectum and lower sigmoid, radical cancer surgery demands the removal of the entire lower loop with sacrifice of the much-desired sphincter muscle. Technically it is desirable either to maintain the sphincter muscle and pull the colon through it or to make an end-to-end anastomosis just above the level of the sphincter. From the radical cancer viewpoint these procedures are not advisable.

It is also necessary to be able to do a careful lymph-node dissection of the nodes lying along the inferior mesenteric vessels which drain the tumor-bearing area.

Of all the methods described in the chart one finds that the Lahey technic answers all these desiderata in the best way if a two-stage operation is desired. The basic principles seem excellent and his method does away with most of the disadvantages of the other methods.

The technic advised by Doctor Lahey was described by him in his article in *Surgery, Gynecology and Obstetrics* in November, 1930. In concise form the main procedure is as follows: Mid-line incision between the umbilicus and the pubis. Exploration for metastasis and operability of the tumor. Determination of a point on the sigmoid colon well above the tumor which will easily reach the surface of the skin above the pubis. At this point incision of the peritoneum on either side of the meso-sigmoid and division of all vessels from the margin of the intestine down to the promontory of the sacrum avoiding the superior hemorrhoidal artery and vein.

Counter incision in the left inguinal region mid-way between the umbilicus and



anterior superior spine for emergence of the permanent colostomy A long Ochsner clamp is introduced through this wound and grasps the colon at the point where the vessels have been divided Another Ochsner clamp grasps the sigmoid in the mid-line wound just below the point of the first clamp The intestine is divided with a cautery, sterilizing the cut margins

The first clamp with sigmoid is withdrawn through the colostomy wound The counter incision is closed, surrounding the colon in layers but not grasping the colon wall to avoid penetration leakage and infection The clamp is left in place in the dressing until the colostomy is to be opened

Method	One stage abdomino sacral procedure	Niles procedure, 1912	W J Mayo's procedure, 1912	Rankin's procedure, 1929
Stages	1 Stage	2 Stage	2-3 Stage	2 Stage
Principles of Operation	Obstructive colostomy Establishing an obstruction colostomy and at the same time removal of entire lower loop with tumor, with extension pelvic dissection and pelvic drainage	Obstructive colostomy Colostomy established At same procedure all vessels to rectum divided and lower loop pushed into pelvis and extra peritonealized by closing peritoneum above it	Non obstructive loop colostomy All blood supply divided Blind efferent loop of non obstructive colostomy which sometimes needs removal later Pelvic dissection and leaving dead loop in pelvis as in Niles procedure	End colostomy Lower divided distal end of colon closed and dropped back into abdominal cavity, keeping blood supply for lower segment till second stage
Advantages of operation	Answers cancer principles best Colostomy and removal tumor in one stage The Ideal Method	Second stage extra-peritoneal	Non obstructive colostomy	Maintains blood supply to lower colon between stages and establishes non obstructive colostomy
Disadvantages of operation	Shock and high mortality	Obstructive colostomy Extension pelvic dissection with raw surfaces into which a dead segment of bowel containing infected faeces is imbedded in pelvic pocket closed by suturing pelvic peritoneum over it	Same as for Niles plan except colostomy being non obstructive Danger opening blind end of efferent loop of colostomy with resulting infection and possible peritonitis	Closed blind lower segment between stages Prevents irrigation lower segment and removal fecal material Impractical if obstruction at site of neoplasm

The mesentery of the upper loop is sutured to the parietal peritoneum in the iliac fossa to prevent herniation and strangulation of the ileum behind the colon

The mid-line incision is sutured in layers above the lower loop which emerges just above the pubis and to which the clamp is still attached This tissue cuts through in about a week and the intestine is opened The colostomy is opened when considered wise

When the lower loop is open the loop is irrigated daily with a rectal speculum in place to allow free flow of fluid

Before the second stage is performed the lower loop is irrigated daily with either S T 37 or with mercurochrome in order to get the loop as sterile as possible When the patient is in good enough condition the second stage is performed The colostomy

## TWO-STAGE ABDOMINOPERINEAL OPERATION OF RECTUM

opening just above the pubis is circumcised and the opening closed and the abdominal wound is again reopened. The stump is painted with iodine. The peritoneum over the superior hæmorrhoidal vessels is incised and the vessels are ligated. The peritoneum is then incised along either side of the rectum and in front, and the dissection is carried downward into the hollow of the sacrum and laterally together with the lymph nodes tissue. In front the rectum is separated from either the bladder or the uterus. This is continued down to the level of the coccyx. The intestine is pushed down and the pelvic peritoneum is closed above the intestine and the abdominal wound is closed.

The patient is then placed in the right Sims' posture. The anus is sutured. The

Cecostomy	Dahlgren's procedure, 1913	Jones procedure, 1915	Coffey's procedure	Lahey's procedure, 1930
2 Stage	3 Stage	2 Stage	2 Stage	2 Stage
Cecostomy to overcome obstruction Cecostomy to overcome obstruction and then to follow with one of other procedures	Preliminary closed cecostomy Ligation of central vessels preserving arch close to Cecum. All the right side and sigmoid dropped back. Opening cecostomy second stage. In third stage dissection from perineum and formation of blind extra peritoneal stump	Non obstructive loop colostomy Central ligation vessels from sacrum, bladder or uterus and lateral attachments and then suturing free pelvic peritoneum to colon above point where it is to be divided above tumor and above point of central ligation vessels. In second stage removal completely extra peritoneal	Colostomy 1 Ligation all vessels to rectum. Suture tal tube to ligated tal end colon. With drawing of tube and telescoping rectum on itself till pulled through and out at anus. 2 Placing dead loop into pelvis as in Niles plan except with drain	Non obstructive colostomy Blood supply to lower intestine but instead of dropping same into abdomen as in Rankin plan, the lower colon is placed in lower angle median wound and lower colon can thus be irrigated and partially sterilized. In second stage blood supply is divided and pelvis dissected from above and then removed completely from below with adequate drainage of pelvis
Overcomes obstruction symptoms	Maintenance of blood supply	Permits establishment fecal stream, and irrigation lower loop between stages and interval between stages. Second stage can be performed extra peritoneally	Drainage established to dead segment with possibility of some delay between stages	Non obstructive colostomy. Division operation into two stages of which two is more extensive. It is nearest to ideal one stage plan. Delay between stages possible. No dead bowel implanted into freshly dissected pelvis. Second stage involves removal clean, empty rectum. Good drainage established
Fluid contact bowel at cecum Only partial side tracking intestinal flow	Many obvious disadvantages including cecostomy	Blind distal open if sigmoid must be left. Difficult intra pelvic, extra peritoneal technique with division sigmoid and closure of end of sigmoid. Shortness of some meso sigmoids in order to reach below pelvic peritoneal diaphragm	1 Telescoping impossible in tumors that constrict rectum 2 Same as in Niles procedure	None except that it is two-stage operation. Peritoneum of pelvis cannot be closed from above if tumor is very large. This is a very minor disadvantage. Difficult in very obese patients to bring distal end cut colon to skin surface

coccyx is resected and the rectum and anus are easily dissected and the entire lower loop is removed in one piece. A large pelvic drain is placed.

The first stage of the operation in the case presented this evening was performed without knowledge of Doctor Lahey's technic and was therefore performed according to the speaker's ideas, which, however, were not as good as those of Doctor Lahey. He doubly ligated the colon and the efferent lower loop was buried with a silk purse-string. This was opened later.

The Ochsner clamp method is much simpler and more preferable. The second stage (Fig 12) was performed according to Doctor Lahey's technic after attention had been brought to his publication. The patient, sixty years of age, had a bad myocarditis and

both stages were performed under spinal neocaine anaesthesia. The second stage was performed under two separate injections of spinal anaesthesia, one before the laparotomy and the other after the patient had been turned onto his side. It might have been possible to perform the entire operation with one injection but we wanted to surely avoid inhalation anaesthesia and therefore two injections were given. There was not the slightest shock to the patient from either one of the stages.

**CASE REPORT**—C. L., a male, sixty-one years of age, was admitted on June 9, 1931, with the chief complaint of bleeding from the rectum for four years, pain in the rectum for one year and prolapse of the rectum for one and one-half years. The bleeding occurred every two to three months for the past four years, the last time one week before admission. The rectum prolapsed at every bowel movement for one and one-half years. For one year he had cramp-like pain in the lower abdomen especially on the left side. This was relieved by a bowel movement or by hæmorrhage. For the past eight months there was marked mucous discharge. Stool was blood-tinged and ribbon-like. Some diarrhoea. Had lost 22 pounds in weight in one year, 10 pounds in the last three months.

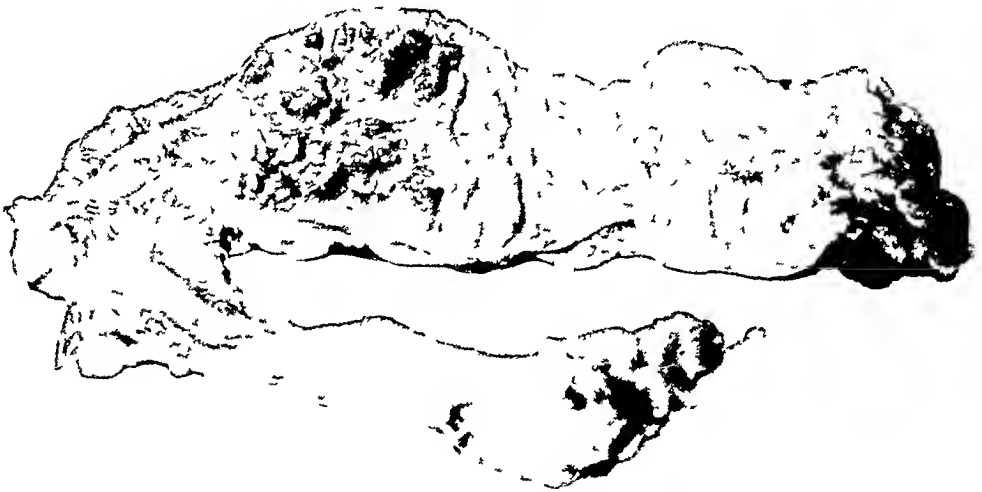


FIG. 12.—Photograph of lower segment of sigmoid, rectum and anus removed in second stage of Lahey's two-stage abdominoperineal operation showing tumor at rectosigmoid junction.

Seventeen years before admission hæmorrhoidectomy. No history of cancer in family.

*Physical examination*—Head and neck negative. Prolapse of the rectum. Prostate normal. A mass was palpable one inch above the prostate about the size of a hen's egg. There was blood on the examining finger. The lower limit could just be touched by the finger. The liver was not enlarged.

*X-ray examination* reveals a deformity at the rectosigmoid juncture.

*Proctoscopy*—Tube introduced 5 inches. Tumor seen. Biopsy taken. *Diagnosis*—Adeno-carcinoma of rectum.

First stage of operation on June 15 under spinal anaesthesia. Orange-size tumor found at juncture of rectum and sigmoid. Freely movable with no evident lymph-node metastasis. Not adherent. Sigmoid freed by incising lateral peritoneum. Division of mesentery down to superior hæmorrhoidal vessels. Distal end of divided colon closed and invaginated. Proximal end ligated and cauterized and brought out through a lateral incision. This wound was closed in layers catching the wall of the colon. (This later gave a local infection and lateral perforation of the colostomy which had to be divided into end opening.) The abdominal mid-line incision was closed in layers with through and through heavy silk sutures and a piece of rubber dam was placed above the lower segment. This according to Lahey's technic is not necessary.

## TWO-STAGE ABDOMINOPERINEAL OPERATION OF RECTUM

The colostomy was opened June 17. The rubber dam was removed June 23. Infection around colostomy on June 24. Lower loop was opened June 26 and irrigations through this loop were begun daily. The patient was allowed out of bed July 19.

The second stage of the operation was performed August 5, all of this time having been used to get patient into better condition and to improve the myocarditis. Spinal anesthesia. Mid-line colostomy closed. Free peritoneal cavity easily entered. One loop of ileum adherent to sigmoid easily freed. Superior hemorrhoidal vessels ligated. Peritoneum and meso-sigmoid and rectum incised. Bladder pushed away. Entire mass could not be pushed into pelvis on account of size of the tumor and the pelvic peritoneum could not be sutured above intestine at this time on account of size of tumor. Abdominal wound closed in layers with drainage and with through and through silk sutures.

The patient was placed in right Sims posture. An additional injection for spinal anesthesia given. 150 milligrams neocaine each time. Anus closed by suture and mid-perineal incision. Cecum removed. Rectum dissected free and entire lower segment of bowel easily removed. Tampon placed in pelvis. Peritoneum sutured about it and lower wound disinfectet with 5 per cent iodiform ether. Packed with gauze.

The convalescence was smooth. September 25 the abdominal wound was entirely healed and November 7 the perineal wound was also closed. Patient was discharged on that day. He had been kept in the hospital all that time because he had no home where he could receive proper care.

*Pathological report*—The specimen was 40 centimetres long. 10.5 centimetres above the anus was an annular, irregular, necrotic growth 5 centimetres in length and 7 centimetres in diameter. Eight smaller and larger lymph nodes were examined. Microscopical examination showed a typical adenocarcinoma. There were many mitoses. Acini were large and lined with multiple layers of cylindrical cells. The growth deeply infiltrated the gut wall reaching at one place almost to the thickened serous coat. There were large areas of necrosis and suppuration.

The regional lymph nodes examined showed no evidence of secondary tumor deposits.

*Follow-up*—It is now five months since the second stage of the operation and the patient is in good condition with no evidence of local or distant recurrence.

**CONCLUSIONS**—(1)—The Lacey technic seems to be the nearest to the ideal one-stage procedure and is the safest method of combined abdominoperineal removal of a cancer of the rectosigmoid in two stages.

(2)—Delay between the stages is possible.

(3)—An end colostomy is performed.

(4)—The entire lower loop with the regional lymphatics can be dissected and removed after fixing it of all fecal content and having it as near sterile as it is possible to get it.

(5)—Adequate pelvic drainage can be instituted.

(6)—The operation is divided into two almost equal stages in which the second stage is the major of the two stages at a time when the condition of the patient has been markedly improved.

(7)—The only disadvantage, besides a two-stage procedure, is a possible difficulty of bringing the distal end of the divided colon to the skin surface above the pubis in very obese patients.

DR CHARLES L. JANSSEN called attention to the necessity of different technic when dealing with cases of carcinoma of the rectum. The most satisfactory in general is the abdominoperineal in one stage. But obesity in some cases makes this dangerous, especially in the male where the pelvis is

narrow and deep The speaker referred to a case in which he did an operation similar to the Lahey technic, but he did not see what benefit was obtained except that a colostomy being performed it is possible to irrigate the lower part and get the rectum perfectly clean He thinks that the two-stage technic used by Jones or Coffey has probably more advantages than the Lahey technic If two stages should be preferred the first should be strictly abdominal and the second strictly perineal to limit the shock

DR FRANK S MATHEWS referred to two cases, both one-stage operations The first required catheterization all the time he was in bed and even then could not empty the bladder completely In the second case the patient could void from the first day and never had any trouble in this respect

DR JOHN C A GERSTER said that in the case of a very stout man he tried the Lahey technic A short bowel made it impossible to get good union with the skin There was local infection At the second operation there were many adhesions The patient was a very stout man with a small pelvic cavity If he had such a case again he would do the one-stage operation because of the delay and danger of infection around the wound The Lahey operation may be successful with thin people but not in very stout ones with a short meso-sigmoid

DR FORDYCE B ST JOHN said that, although relatively infrequent, the complications which may arise as a result of early retraction into the peritoneal cavity of the colostomy stump should be born in mind

DR FREDERIC W BANCROFT, referring to the bladder complications, said that he recently had a patient who, two weeks after an argyrol irrigation, passed black urine and it was impossible to tell if this was argyrol or the result of some infection As to the Lahey operation there was one difficulty which was illustrated by a recent case of a woman with a high tumor in which it was necessary to do a two-stage operation The difficulty in bringing the proximal end up caused sloughing of the proximal loop and a stricture developed which it was hard to dilate and keep open Eight months after the operation she developed partial obstruction and at operation half of a prune pit was found She died the next day Post-mortem revealed a perforation within the peritoneal cavity with diffuse faecal peritonitis

DR CHARLES E FARR asked if this operation destroys the nerve supply of the bladder and, if so, why do the patients recover bladder function later on

DOCTOR WHIPPLE replied to Doctor Farr's question that he did not see how there could be much nerve supply left after this operation Jones, of Cleveland, recently wrote to him that he was making an effort to preserve some of the plexus but felt, on the other hand, that if one paid too much attention to that one would not get the peri-rectal tissue that contains the lymph nodes Why these patients do not become permanently disabled as

## COMPLICATIONS OF ABDOMINAL PERINEAL RESECTION OF RECTUM

far as bladder function is concerned the speaker did not know. In regard to anaesthesia, many surgeons have experienced the advantages of spinal anaesthesia up to the end of one hour and after that being faced with the necessity of using another anaesthetic. Perhaps that is why Myles, of London, times his operation for one hour. But he selects his patients, ideal as far as lack of obesity is concerned. He also has very good assistants and that is of great importance in developing a technique and shortening the operative time.

DR HERBERT WILLY MEYER said that the patient he had presented that evening had been operated upon under spinal anaesthesia on account of the fact that he had a very bad myocarditis.

The entire operation of the second stage of the procedure was performed under spinal anaesthesia and this was maintained by two separate injections of 150 milligrams of neocaine. The first injection was made and then the laparotomy performed whereupon the patient was turned into the right Sims' posture, and a second injection was made before the perineal work was done. Only one injection of ephedrin was given at the beginning and the patient went through the operation without any evidence of shock whatsoever, excellent analgesia being maintained throughout. It seems that one can use two injections of spinal anaesthesia without much danger. Bartlett, of St. Louis, has also used this method, reversing the procedure and first operating perineally and then performing the laparotomy under two injections of spinal anaesthesia.

Doctor Meyer stated that he did not mean that the Lahey technique should be used in every case of carcinoma of the rectum but he did wish to state that in certain cases it certainly was the safest and most ideal method.

## THE COMPLICATIONS OF ABDOMINAL PERINEAL RESECTION OF THE RECTUM

DR ALLEN O. WHIPPLE read a paper with the above title for which see page 916.

# TRANSACTIONS

OF THE

## PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD JANUARY 4, 1932

The President, DR GEORGE P MULLER, in the chair

CALVIN M SMYTH, JR M D , Recorder

### AVULSION SKIN OF HAND

DR HUBLEY R OWEN presented a man twenty-seven years of age who, July 20, 1931, as a result of an automobile accident, sustained a lacerated wound of the scalp, cerebral concussion and a severe laceration of his right hand with loss of skin and subcutaneous tissues from the dorsum exposing



FIG 1

FIG 2

FIG 1—Avulsion skin of hand with exposure and sloughing of tendons  
FIG 2—Flap a few days after being freed from chest

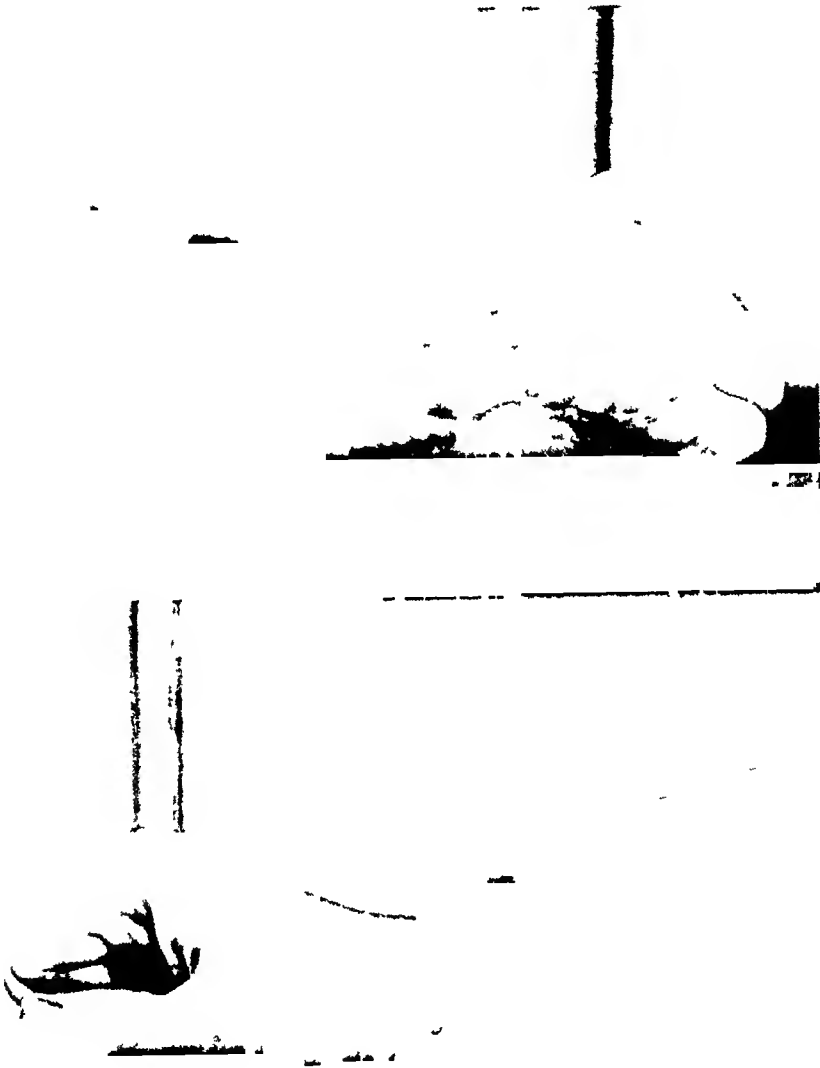
the tendons and deeper structures. The extensor tendons of the four fingers and thumb were badly lacerated. The trapezium was crushed and the joint between it and the first metacarpal was exposed. The wound was cleansed, debrided and part of the trapezium removed. He received appropriate treatment for his cerebral concussion. Cultures from the lacerated wound of the hand showed an organism resembling *B. welchii* as well as the tetanus bacillus. He was given perfringens antitoxin and tetanus antitoxin. The above treatment was rendered at the Atlantic City Hospital.

He was admitted to the Police and Fire Ward of the Philadelphia General Hospital July 24, 1931, at which time (Fig 1) the dorsum of the right hand was denuded of skin and the tendons of the third, fourth and fifth fingers exposed. The wound was grossly infected. The wound of the

## AVULSION SKIN OF HAND

hand was treated with Dakin's solution by the Carrel method. On July 28 smear and culture from hand were negative for gas bacillus but there were present a few bacilli suggestive of tetanus.

A pedicle flap from the chest was sutured over the wound of the hand on August 21, the graft being freed from the chest wall August 27 (Fig 2). He was discharged from the hospital September 3. Massage was first



FIGS 3 and 4 —End results

ordered on October 28. He has regained practically 100 per cent function with the right hand (Figs 3 and 4). Reconstruction of his tendons has been effected without a secondary operation and he is performing his regular duty as fireman in the Bureau of Fire.

DR DEFOREST P. WILLARD discussing whether the graft should be taken from the abdomen or the chest believes that the chest is better as there is not as much fat on the chest as in the abdominal wall. Some years ago he had a patient who had had a very massive burn on the back of the hand. A flap graft had been made when she was seventeen or eighteen years of age and excessively thin. After she had been married she became very stout after the birth of a child. The fat had simulated the fat of the abdominal wall.



DR HUBLEY R. OWEN said that the flap in his case was taken from the axillary region rather than from the abdomen for two reasons. "First, because he thought the position with the hand in the axilla was more comfortable, and secondly because of his knowledge of a case of Doctor Willard's which developed *adiposa dolorosa*. Doctor Willard took the flap from the abdomen and when the patient developed increased thickness of the walls of the abdomen, the flap which had been transferred to the hand assumed the same thickness. The graft in his own case was attached to the chest wall for six days. The real interest of the case was the reconstruction of the tendons which were so frayed and sloughed that there appeared to be but little possibility of ever regaining function without operative procedure.

#### TRAUMATIC CHOLECYSTECTOMY

DR HENRY P. BROWN, JR., reported the case of a man of eighteen years who was admitted in the service of Dr. Edward B. Hodge at the Presbyterian Hospital May 9, 1931, with the history that twelve hours previously he had been in an automobile accident in which, while riding in the rumble seat, he was thrown violently against the front seat of the car. He was brought to the hospital in an unconscious condition. He recovered consciousness soon afterwards and was treated for abrasions of the face and allowed to go home. He returned to the hospital several hours later (twelve hours after the accident), complaining of vomiting and abdominal pain. At this time his temperature was 99°, pulse 92 and respiration 38, the blood-pressure being 138 systolic and 78 diastolic.

He was a well-developed male lying partly on the right side, with the right thigh and leg held in a flexed position. He complained of severe abdominal pain, which he characterized as being knife-like. He was also nauseated and tried ineffectively to vomit. Respirations were rapid and shallow, deep breathing causing abdominal pain. Aside from lacerations of the scalp and chin, examination of the head was negative, as was examination of the chest and its contents. The abdomen showed marked generalized rigidity and tenderness, being more marked under the right costal border. Peristalsis was not heard and there was no demonstrable free fluid in the abdomen. There were no masses present in the abdomen, nor was there evidence of local trauma to the abdominal wall. There was well-marked tenderness over the region of the right kidney, without evidence of a mass. The extremities were negative. The urine showed a specific gravity of 1.030, acid, trace of albumen, 150-200 red blood cells per high-power field. The blood showed 4,320,000 erythrocytes, 20,000 leucocytes, polymorphonuclears 95 per cent and small lymphocytes 5 per cent. The haemoglobin was 85 per cent. Fluoroscopic examination of the chest did not reveal anything abnormal, the diaphragm moving equally but slightly on both sides.

A diagnosis of abdominal trauma having been made, operation was performed within thirteen hours of the time of the accident. Spinal anaesthesia was employed. The abdomen was opened through a right paramedian incision, revealing a large amount of free blood in the abdominal cavity. Examination of the stomach was negative, as was that of the spleen and intestines. The liver showed a tear 3 centimetres in length on the dorsal surface above the bed of the gall-bladder. Exposure of the under surface of the liver revealed that the gall-bladder had been removed entirely from its bed and was floating free in a pool of blood, it had been severed

## ACUTE INTUSSUSCEPTION WITH REFERENCE TO BOWEL TREATMENT

flush with the common duct. There was also a small tear on the under surface of the liver in the region of the gall-bladder bed. The cystic artery had been severed and was plugged with a clot. After ligating the cystic artery, the orifice of entrance of the cystic into the common duct was closed with one mattress suture of catgut. The torn edges of the liver were sutured with a few catgut sutures and the torn peritoneum was sutured over the ligated cystic artery and the entrance of cystic duct into the common.

About 400 cubic centimetres of free blood were removed from the abdomen, the rest being allowed to remain. A cigarette drain was placed against the bed of the gall-bladder and the abdomen was closed in layers.

Aside from being irrational at times for three or four days, the patient made a normal post-operative recovery. Within the first twenty-four hours post-operatively, he began to drain bile profusely, which continued for six days, at which time it stopped rather suddenly. On the second post-operative day there was a suggestion of icterus of the sclera which disappeared on the third day following. The cigarette drain was removed on the eleventh day, at which time the sutures were also removed, and on May 30, twenty-one days after the operation, the wound had entirely healed. His stool was normal in color, there was no jaundice, his appetite was excellent, and he was discharged as cured. His post-operative temperature ranged from 100 to 101° for five days, becoming normal and remaining so after this time. The urine showed red blood cells only on the first examination. The Wassermann and Kahn tests were negative. Microscopically, the gall-bladder showed complete desquamation of the lining epithelium.

This case was the first time that the reporter had ever encountered a traumatic amputation of the gall-bladder and he was unable to find reference to a similar condition.

## FRACTURE OF THE SURGICAL NECK OF THE HUMERUS

DR HENRY P. BROWN, JR., reported the case of a boy nine years of age who was injured February 6, 1930, while wrestling with some other boys. He stated that he was thrown violently to the ground, striking his right shoulder. He had immediate disability of his right arm and was brought to the Pennsylvania Hospital and admitted to Dr. Charles F. Mitchell's service. Examination at this time was negative, aside from his right arm, which revealed a fracture of the surgical neck of the humerus, which was confirmed by X-ray examination. He was put to bed and an extension applied to the arm through a Thomas splint. It being impossible to keep this splint and traction in position, this method was discarded and the arm put up in a sling and shoulder cap. At this time the X-ray showed complete displacement with over-riding of the lower fragment. He was discharged from the hospital February 23. Attempt at reduction had been made first under nitrous oxide and again under ether anaesthesia without improving the position of the fragments. His condition progressed satisfactorily and in three months' time he had resumed his former occupation as a bootblack.

Examination of the arm in October, 1931, which was twenty months after the injury, showed complete restoration of the line of the humerus, there being scarcely any evidence of the former fracture. Function at this time was perfect.

## ACUTE INTUSSUSCEPTION WITH SPECIAL REFERENCE TO TREATMENT BY RESECTION OF THE BOWEL

DR FREDERICK R. ROBBINS read a paper with the above title for which see page 830.

## FRACTURE OF THE ODONTOID PROCESS OF THE AXIS

DR ASTLEY P C ASHHURST reported the case of a man fifty-seven years of age, weighing 195 pounds, who was in an automobile accident March 6, 1931, in which the patient was thrown through the top of the car and fell about 15 feet away from its wreck. He did not lose consciousness, but managed to get up on his hands and knees. After having been placed in another automobile he was driven several miles to a dentist's office. He was taken on a stretcher to a hospital in Burlington, N C, bleeding from his nose and his right ear. He remained in that hospital for three weeks. He was then taken to Asheville, N C, and was under the care of Dr Charles Norburn in the latter's hospital. Doctor Norburn applied a plaster-of-Paris dressing including the body and head, when this dressing was removed after being in place four weeks, the patient seemed comfortable without support, and it was not replaced. X-ray films taken soon after the accident (both antero-posterior and lateral views) showed a transverse fracture through the base of the odontoid process, without any displacement. The patient also had a fracture of the right clavicle, and probably also a fracture of the base of the skull on the right.

The patient was sent by Doctor Norburn to Doctor Ashhurst, at the Episcopal Hospital, Philadelphia, June 10, 1931, three months after the accident. He was a stocky, thick-set man, looking his given age. He walked about easily, but with his neck held a little stiffly. All motions of his neck were very limited, he had no pain, he said, unless motions were pushed beyond these limits. Doctor Ashhurst made no attempt at all to force the motions. There was no deformity palpable on the outside of the neck or in the pharynx. A spinal brace with head extension, was ordered, to be worn constantly except in bed. The brace consisted of a pelvic band, to which were attached two uprights (one each side of the spinal column) which were continued forward over the shoulders, and a headpiece attached to the spinal support by a pivot joint allowing a little rotation of the neck, but no flexion, extension or side bending.

The patient was seen again October 7, 1931. He had been wearing the brace with comfort since June. Recent X-ray films made in Asheville, and by Dr H K Pancoast in Philadelphia, showed the odontoid process in normal position, and with bony union of the fracture across its base. The patient was therefore allowed to discontinue the use of the brace except when in an automobile or railroad train on long trips. Doctor Norburn writes January 1, 1932, that the patient has gone to Florida for his general health (very high blood-pressure, having suffered an apoplectic stroke some time ago). However, the condition of his neck is quite satisfactory, he having about 75° rotation, and slight limitation in flexion and extension.

The patient himself writes from Florida December 30, 1931: "I feel little or no discomfort at all about my neck."

N B—Magnant (Rev de Chin, vol 1, pp 13-33, 1931) finds fracture of the odontoid process of the atlas occurs only in 3 to 4 per cent of fractures of the vertebral column. As an isolated lesion it is still more rare, only ten cases being recorded.

An excellent article on the subject in German is by Durck (Beitr z path Anat u z allg Path vol lxxxiv, pp 353-373, 1930).

DR WALTER ESTELL LEE recalled three cases of fracture of the odontoid process, two of the patients recovered and the other died suddenly while being

given an enema by the orderly. He has at the present time under his care a man seventy-four years of age who was injured in an automobile accident and although he had a painful and rigid neck immediately after the accident, his other bruises seemed to attract more attention. The painful neck persisted and an X-ray picture was taken seven days after the accident. This picture demonstrated a very definite transverse fracture at the base of the odontoid. A brace was applied, which he wore in bed for about a month, but it is now discarded and although there is still considerable limitation of motion, the pain has entirely disappeared and the speaker believes that he can be considered as having recovered.

DR ADDINELL HEWSON exhibited a specimen showing a fracture of the odontoid process. This is the second one of the kind he has come across, but this one shows roughened areas of the ventral and dorsal surfaces of the body. The other one he found in a dissecting room at Jefferson College, which showed the odontoid process was not united at all, that the area between the odontoid process and the body of the second vertebra was covered with cartilage and apparently the odontoid process had not been disturbed after the fracture had taken place. It is interesting from the standpoint that the callus is on the front part of the vertebra and the other on the dorsal portion. The opening for the large veins which go into the body of the vertebra in this instance is quite large. It is interesting from the position of the odontoid process and the spinal cord. The odontoid process would come very close to the position of a crossing of the fibres in the pyramids of the cord. The speaker had examined eight bodies within three hours after execution by hanging and in none of them did he find any trouble with the odontoid process.

DR FRANCIS C GRANT said that he had seen the case of a man thrown through the top of an automobile who sustained a fracture of the odontoid process. The injury went ten days unrecognized and was then diagnosed by X-ray. The man wore a brace for six or eight months and made a complete recovery. As far as the speaker could remember there has been none on the neurosurgical service in the University Hospital for the last five years.

Doctor Ashhurst added, in reference to Doctor Hewson's experience with patients who had been hanged, that it was interesting to recall the controversy which was carried on years ago between the surgeons of Paris and the surgeons of Lyons, France. The former contended that the neck was never fractured by hanging, whereas the latter maintained that it was always fractured. Further investigation showed that the Lyons hangman, being anxious to assure himself of the death of his victims, after removal from the gallows, made a practice of sitting on their shoulders, and *twisting the neck around until he heard it crack!*

## BRIEF COMMUNICATIONS

### SIMULTANEOUS STRANGULATION OF TWO SEPARATE LOOPS OF INTESTINE

THE following report of a case in which there was present strangulation gangrene of two separate loops of small intestine is reported for four reasons

(1) As far as can be learned there are no similar cases reported in the literature. The research department of one of our leading publishing companies was unable to find any references in the literature.

(2) Advanced age is not always a contra-indication to rather extensive surgery. When a condition such as this patient had is present in which the outcome without operation is certain death, the patient should be given the chance afforded by operative procedure.

(3) If the few cardinal principles of intestinal anastomosis described by Doctor Halsted are respected, intestinal suturing is a simple procedure and elaborate and time-consuming methods are unnecessary. Doctor Halsted maintained that one row of carefully placed sutures to invert the line of the anastomosis and approximate the serous surfaces was sufficient. In this particular case one row of inverting sutures was used in the end-to-end anastomosis in the small bowel and the Murphy button was used to make the end-to-side anastomosis of the terminal ileum to the cæcum. Careful respect to technic, particularly to soiling, was given, but no time was wasted, the entire operation being done in less than an hour and before the spinal anæsthesia had worn off.

(4) The drainage of the intestine through an enterostomy tube proximal to the anastomosis (in this case proximal to the proximal anastomosis) I believe is a very important point and should be done in all operations of intestinal resection where previous drainage of the intestine has been impossible. An enterostomy properly done, using a No. 16 to 18 catheter, immediately removes the accumulated toxic content of the obstructed bowel and in the first few post-operative days prevents distension and prevents any strain on the line of anastomosis. When the bowels begin to move normally the tube can be clamped off part of the time, opened if any distension occurs, and removed after it is demonstrated that the anastomosis is working without difficulty.

CASE REPORT—A woman, aged eighty-three years, was first seen March 5, 1932, on account of abdominal pain and vomiting. She had been subjected to hysterectomy twenty years ago for uterine fibroids. There was complete recovery following. Twelve hours before she was seen by me she was seized with severe abdominal pain which came on suddenly, accompanied by severe nausea and vomiting. This pain was at first intermittent in character and throughout the lower abdomen. When first seen there was considerable abdominal distension present. The pattern of the small intestine was plainly visible

## STRANGULATION OF TWO LOOPS OF INTESTINE

through the thin abdominal wall but no peristaltic movements were seen, even after tapping the abdomen. The entire abdomen was tender with moderate muscle spasm of both lower recti muscles, and the intestines had a soft doughy feel but no masses were felt.

It was quite evident that the patient had an intestinal obstruction, which apparently at first was mechanical but which had progressed to the paralytic stage.

She was sent to the Emergency Hospital and was operated upon shortly after her arrival there. Pre-operatively she was given 500 cubic centimetres of 5 per cent glucose intravenously, as well as the usual pre-operative dose of morphia.

The operation was done under spinal anaesthesia using 150 milligrams of neocaine. The abdomen was opened through the previous scar in the lower mid-abdomen, the peritoneal fluid was dark blood-tinged and the presenting small intestines were dark and gangrenous. This gangrenous bowel was found to be ileum which had become strangulated due to an adhesion extending from the terminal ileum to the posterior parietal peritoneum in the region of the promontory of the sacrum. When this adhesion was severed, making it possible to deliver the gangrenous intestine, it was found that there were two separate loops of gangrenous small bowel each about eighteen inches in length with about three feet of normal intestine between them. The distal gangrenous loop extended upward from the ileocecal junction for a distance of approximately eighteen inches and the proximal gangrenous loop began about three feet above this and was of about the same length.

The intervening bowel between the two gangrenous loops was normal except there was a well-developed Meckel's diverticulum three inches in length which was not involved in the present picture. There was considerable thrombosis of the mesenteric vessels supplying the areas of gangrenous intestine but there was no thrombosis of the vessels of the remaining mesentery.

Both loops of gangrenous intestine together with a wide margin of normal intestine on either side, as well as a deep wedge of the mesentery were resected and an end-to-end anastomosis done at the proximal resection, and an end-to-side—that is, end of the ileum to the side of the caecum—done at the distal resection, the latter being done with a Murphy button. A temporary enterostomy using a No. 16 catheter was done just proximal to the proximal anastomosis, and the abdomen closed without drainage, bringing the enterostomy catheter out through a stab wound in the right lower quadrant. The double resection was done as quickly as possible and the Murphy button was used in the one anastomosis on account of the time element.

The patient showed no great amount of shock during the operation and left the operating room in excellent condition. She was given glucose and salt solution in large amounts, both intravenously and subcutaneously, during the first week, and during this first week she received very little by mouth except small amounts of water. There was no distension, no vomiting of any account, and the post-operative course was entirely uneventful. Beginning the sixth day, olive oil was instilled in the rectum, four ounces at a time, and on the seventh day patient began to have spontaneous bowel movements. The drainage from the enterostomy tube stopped as the bowels began moving normally and the catheter was removed on the tenth day.

The Murphy button was not passed at the twelfth day and at this time on digital examination of the rectum it was found in the rectum and easily removed. Except for some troublesome diarrhoea the patient made a smooth recovery and left the hospital in three weeks. At the time of leaving the hospital she was up in a chair most of the time and felt quite well. Since leaving the hospital she has continued to improve and has fully regained her former strength and vitality.

JOSEPH P. SHEARER, M.D.,  
Washington, D. C.

## INTUSSUSCEPTION THROUGH GASTROENTEROSTOMY STOMA

**CASE REPORT**—A woman, aged thirty-five years, had been the subject of three laparotomies, including posterior gastroenterostomy in October, 1923. Relief complete and constant until September 7, 1930, on which date at 2 A M she was awakened by severe pain in upper abdomen, unrelieved by moderate doses of morphia, after some hours marked symptoms of shock developed, abdomen not distended, tender or tympanic, admitted to St Joseph's Hospital where the abdomen was opened by a high incision to the left of the umbilicus. The exposed stomach was greatly distended by the distal portion of jejunum, five feet of which had invaginated through the stoma of the gastroenterostomy. The invaginated bowel was easily withdrawn. It was oedematous, somewhat discolored but yet glistening. It was evident that gangrene had not yet supervened. The stoma would admit three fingers. It was reduced to about one-half this size by interrupted mattress sutures placed on the stomach side of the opening. Prompt and rapid improvement followed the removal of the incarcerated bowel from the stomach. Wound healing uncomplicated. While the immediate results of the operation were satisfactory, there have been later, on a number of occasions, attacks varying in duration and intensity of nausea, vomiting and pain in the upper abdomen. These attacks have always been associated with obstinate constipation. They have, to date, yielded promptly to conservative measures.

*Remarks*—In 1922, Lewisohn, *ANNALS OF SURGERY*, LXXVI, pp 543-545, October, 1922, in reviewing this subject and reporting a case of his own, directed attention to the extreme rarity of the condition, stating that "in forty years of gastroenterostomy, a similar case has not been reported." Subsequent observations have shown, however, that intussusception of the small intestine into the stomach through a gastroenterostomy stoma is not an infrequent complication. The condition may sometimes correct itself. In other words, all cases may not come to operation or autopsy. See article by Shearer and Pickford, *ANNALS OF SURGERY*, LXXXVII, pp 574-577, April, 1928, being a report of twenty-four cases.

NICHOLAS SCHILLING, M D  
New Hampton, Iowa

## JEJUNOSTOMY

AN EXPERIMENTAL STUDY IN A PERMANENT NON-LEAKING  
YET CLOSABLE TYPE

A TERMINAL loop of jejunum is delivered through a small transrectus incision (left preferable). At the base of the loop as shown in Fig 1 a side-to-side anastomosis is done—the opening being about one and one-half inches in length. The anastomosis is done without interference with the mesentery of the bowel and about three-eighths of an inch from its attachment to the bowel.

Midway between the concavity of the anastomosed loop and the upper limit of the enterostomy the lateral wall of the bowel is inverted after scarification of the serosa for a distance of three-fourths inch and sutured as shown in Fig 2EB and Fig 4. This acts as a valve structure, the function of which is to prevent retrograde leakage. Experimentally it has been found that it is unnecessary to make a bilateral valve and that as a rule the valve at the distal part of the loop X at point C is sufficient. The reason for this is that peristalsis in the distal portion of loop (X) is toward the opening D, while in loop Y the peristalsis is away from opening D.

## JEJUNOSTOMY

An opening D is made in summit of convexity of loop (X-Y) and along 25 French catheter or duodenal tube is passed in loop Y beyond point of anastomosis and fixed by purse string at point D. This allows of feeding patient without interfering with operative areas either externally or internally.

At point C the convexity of the loop is sutured to the peritoneum-rectus sheath and skin so that almost one-half inch of loop protrudes above the skin, the abdominal wound is closed in the usual way.

Figure 3 gives a diagrammatic representation of the mechanism of this type of jejunostomy. The tube (F) allows of immediate feeding to distal loop Y without interfering with any of the areas operated. This allows of healing with safety of the entero-enterostomy and the external jejunostomy. After a period of eight to ten days this tube is removed and a tube can be introduced just beyond the opening D without regard to which loop the food is injected since the anastomosis retains the proper flow and continuity of the bowel. The anastomosis besides this prevents leakage of important duodenal contents. The valve E alone or E and B further insure non-leakage.

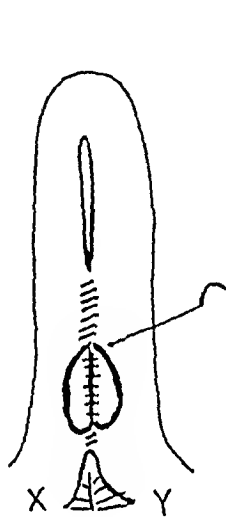


FIG 1

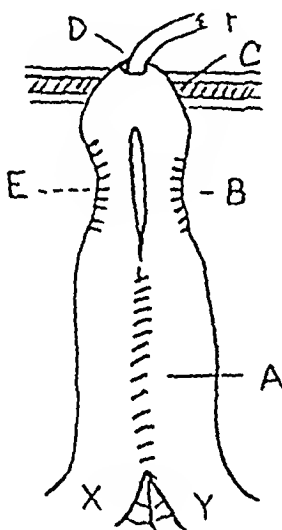


FIG 2

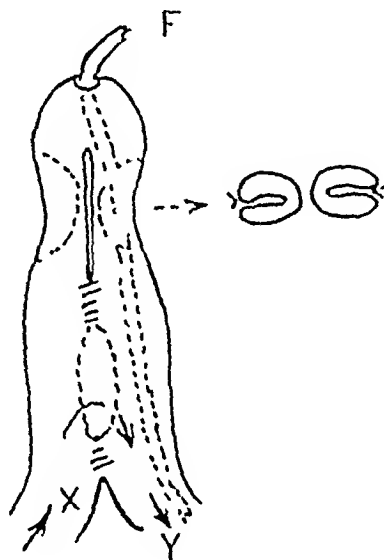


FIG 3

FIG 4

As can be readily seen one can make this type of jejunostomy as permanent as one desires and yet can readily be closed without fear of necessity for extensive operation to restore the continuity of the bowel. To close simply tamponade or suture hole D.

On the dog this type of operation was done very rapidly under local anesthesia without any untoward effects, no leakage or excoriation of skin, and the dogs lived under laboratory conditions for months. In one case the duodenum was used for the above technique, the dog living without leakage for months.

The opening D can be made in various ways, as, for instance, as in Bloodgood's technique for side-to-side anastomosis of the intestine leaving one loop patent or suture of mucosa of jejunum to skin as in the Janeway gastrostomy.

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## BOOK REVIEW

SURGICAL PATHOLOGY By ARTHUR E. HERTZLER, M D 8 vo , 4 vols ,  
Cloth J B Lippincott Co , Philadelphia, 1931

Thus far the author has prepared four monographs consisting of his observations during the past thirty years both as a teacher and as a general surgeon in the fields of the surgical pathology of the (1) Diseases of Bones, (2) Skin, Blood-vessels, Muscles and Nerves, (3) Genito-urinary Organs, and (4) Female Generative Organs. As he states, the subject matter represents essentially his personal viewpoint on the various pathological conditions found and therefore may be found at variance with the conclusions of other qualified observers whose interpretations of certain conditions have perhaps been accepted more widely as being correct.

The material presented is considered under three heads, namely, Pathogenesis, Pathology and Histology, the first linking up the pathology with the clinical aspects, the second depicting what the surgeon sees and feels, including the physical findings and gross pathology, and the final section includes just enough of the finer anatomy to make the gross pathology more intelligible.

The volumes thus far published represent certainly an enormous amount of very carefully correlated labor extending now over three decades, which naturally is of far greater value to the observer personally than to the reader. The experience gained by the very apparent careful evaluation of such an extensive material must indeed be a source of great satisfaction to its possessor. The difficulty of attempting to transmit it to others is practically insurmountable. However, in so far as this is possible, it has been accomplished by the author. The lucidity and succinctness of its presentation is quite exceptional. The illustrations, which average 245 in each of the four volumes, are very excellent and reflect credit on the photographer of these most difficult objects. The monographs average 291 pages each, which makes a volume easy to handle.

To the thoughtful surgeon and much more so, to the younger generation, a most careful study of these exceptionally well-presented studies of the innumerable aspects of surgical pathology must prove of very great aid and benefit not only to them but also in the interest of the patient.

JAMES T. PILCHER

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